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THE ANCIENT LAKES OF WESTERN AMERICA: THEIR DEPOSITS AND DRAINAGE.*

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THE wonderful collections of fossil plants and animal remains brought by Dr. Hayden from the country bordering the Upper Missouri have been shown by his observations, and the researches of Mr. Meek, to have been derived from deposits made in extensive fresh-water lakes; lakes, which once occupied much of the region lying immediately east of the Rocky Mountains, but which have now totally disappeared. The sediments that accumulated in the bottoms of these old lakes show that in the earliest periods of their history they contained salt water, at least that the sea had access to them, and their waters were more or less impregnated with salt, so as to be inhabited by oysters and other marine or estuary mollusks. In due time the continental elevation which brought all the country west of the Mississippi up out of the widespread Cretaceous sea, raised these lake-basins altogether above the sea level and surrounded them with a broad expanse of dry land. Then ensued one of the most interesting chapters in the geological history of our continent, and one that, if fairly written out, could not fail to be read with pleasure by all intelligent persons. The details of

* From Dr. Hayden's forthcoming "Sun Pictures of the Rocky Mountains."

this history are however, in a great measure, yet to be supplied; inasmuch as the great area of our western possessions is still but very partially explored, and it is certain that it forms a great treasure-house of geological knowledge, from which many generations will draw fresh and interesting material before its riches shall be exhausted.

The enlightened measures adopted by our Government for the exploration of the public domain, the organization and thorough equipment of the numerous surveying parties that have traversed the region west of the Mississippi within the last twenty years, together with the more extensive explorations by private enterprise of our great mining districts, have resulted in giving us materials from which an outline sketch can now be made that may be accepted as in all its essential particulars, accurate and worthy of confidence.

It has happened to me to be connected with three of the Government surveys, to which I have referred, and to spend several years in traversing the great area lying between the Columbia River and the Gulf of Mexico. The observations which I have made on the geological structure of our Western Territories supplement, in a somewhat remarkable way, those made by Dr. Hayden, so that taken together, our reports embody the results of a reconnoissance stretching over nearly the whole of our vast possessions west of the Mississippi.

Our knowledge of the geology of this region has also been largely increased by the no less important contributions of other explorers. Among those who deserve most honorable mention in this connection are Mr. George Gibbs, to whom we are indebted for most that we know of the geology of Washington Territory; to Professors W. P. Blake and Thomas Antisell, to Prof. Whitney and the other members of the California Geological Survey; to Baron Richtofen, the lamented Rémond, Drs. Shiel, Wislizenus, and others.

The results obtained by the last, largest and best organized party which has been engaged in Western explorations,

that of Mr. Clarence King, have not yet been given to the public, but from an examination of some of the materials which are to compose the reports of this expedition, I feel justified in saying that it will prove to be among the most important of all the series of explorations of which it forms a part, and that the published results of this expedition will be not only an important contribution to science and our knowledge of our own country, but a high honor to those by whom the work has been performed, and to the Government by which it was organized.

Without going into details or citing the facts or authorities on which our conclusions rest, I will, in a few words, give the generalities of the geological and topographical structure of that portion of our continent which includes the peculiar features that are to be more specially the subject of this paper.

It is known to most persons that the general character of the topography of the region west of the Mississippi has been given by three great lines of elevation which traverse our territory from north to south: the Rocky Mountain Belt, the Sierra Nevada and the Coast Ranges. Of these, the last is the most modern, and is composed, in great part, of Miocene Tertiary rocks. It forms a raised margin along the western edge of the continent, and has produced that "iron bound coast" described by all those who have navigated that portion of the Pacific which washes our shores.

Parallel with the Coast Mountains lies a narrow trough which, in California, is traversed by the Sacramento and San Joachin Rivers, and portions of it have received their names. Further north, this trough is partially filled, and for some distance, nearly obliterated by the encroachment of the neighboring mountain ranges, but in Oregon and Washington it reappears essentially the same in structure as further south, and is here traversed by the Williamette and Cowlitz Rivers.

These two sections of this great valley have now free

drainage to the Pacific, through the Golden Gate and the trough of the Columbia, both of which are channels cut by the drainage water through mountain barriers that formerly obstructed its flow, and produced an accumulation behind them that made these valleys inland lakes; the first of the series I am to describe of extensive fresh-water basins that formerly gave character to the surface of our Western Territory, and that have now almost all been drained away and have disappeared.

East of the California Valley lies the Sierra Nevada; a lofty mountain chain reaching all the way from our northern to our southern boundary. The crest of the Sierra Nevada is so high and continuous that for a thousand miles it shows no passes less than five thousand feet above the sea, and yet, at three points there are gate-ways opened in this wall, by which it may be passed but little above the sea-level. These are the cañons of the Sacramento (Pit River), the Klamath and the Columbia. All these are gorges cut through this great dam by the drainage of the interior of the continent. In the lapse of ages the cutting down of this barrier has progressed to such an extent as almost completely to empty the great water basins that once existed behind it, and leave the interior the arid waste that it is— the only real desert on the North American Continent.

The Sierra Nevada is older than the Coast Mountains, and projected above the ocean, though not to its present altitude, previous to the Tertiary and even Cretaceous ages. This we learn from the fact, that strata belonging to these formations cover its base, but reach only a few hundred feet up its flanks. The mass of the Sierra Nevada is composed of granitic rocks, associated with which are metamorphic slates, proved by the California Survey to be of Triassic and Jurassic age. These slates are traversed in many localities by veins of quartz, which are the repositories of the gold that has made California so famous among the mining districts of the world.

East of the Sierra Nevada we find a high and broad plateau, five hundred miles in width, and from four thousand to eight thousand feet in altitude, which stretches eastward to the base of the Rocky Mountains, and reaches southward far into Mexico. Of this interior elevated area the Sierra Nevada forms the western margin, on which it rises like a wall. It is evident that this mountain belt once formed the Pacific coast; and it would seem that then this lofty wall was raised upon the edge of the continent to defend it from the action of the ocean waves. In tracing the sinuous outline of the Sierra Nevada, it will be seen that its crest is crowned by a series of lofty volcanic cones, and that one of these is placed at each conspicuous angle in its line of bearing, so that it has the appearance of a gigantic fortification, of which each salient and reëntering angle is defended by a massive and lofty tower.

The central portion of the high table lands, to which I have referred, was called by Fremont the Great Basin, from the fact that it *is* a hydrographic basin, its waters having no outlet to the ocean. The northern part of this area is drained by the Columbia, the southern by the Colorado. Of these the Columbia makes its way into the ocean by the gorge it has cut in the Cascade Mountains, through which it flows nearly at the sea level; while the Colorado reaches the Gulf of California through a series of cañons, of which the most important is nearly one thousand miles in length, and from three thousand to six thousand feet in depth. In volume VI. of the Pacific Railroad Reports, I have described a portion of the country drained by the Columbia, and have given the facts that led me to assert that the gorge through which it passes the Cascade Mountains has been excavated by its waters; and that previous to the cutting down of this barrier these waters accumulated to form great fresh-water lakes, which left deposits at an elevation of more than two thousand feet above the present bed of the Columbia. Similar facts were observed in the country drained by the

Klamath and Pit Rivers, and all pointed to the same conclusion.

In all this region I observed certain peculiarities of geological structure that have been remarked by most of those who have traversed the interval between the Sierra Nevada and the Rocky Mountains. In the northern and middle portions of the great table lands the general surface is somewhat thickly set by short and isolated mountain ranges, which have been denominated the "Lost Mountains." These rise like islands above the level of the plain, and are composed of volcanic or metamorphic rocks. The spaces between these mountains are nearly level, desert surfaces, of which the underlying geological structure is often not easily observed. Toward the north and west, however, wherever we come upon the tributaries of the Columbia, the Klamath or Pit Rivers, we find the plateaus more or less cut by these streams and their substructure revealed.

Here the underlying rocks are nearly horizontal, and consist of a variety of deposits varying much in color and consistence. Some are coarse volcanic ash with fragments of pumice and scoria. Others I have in my notes denominated "concrete," as they precisely resemble the old Roman cement and are composed of the same materials. In many localities these strata are as fine and white as chalk, and, though containing little or no carbonate of lime, they have been referred to as "chalk-beds" by most travellers who have visited this region. Specimens of this chalk-like material gave me my first hint of the true history of these deposits. These, collected on the head waters of Pit River, the Klamath, the Des Chutes, Columbia and elsewhere, were transmitted for examination to Professor Bailey, then our most skilled microscopist. Almost the last work he did before his untimely death was to report to me the results of his observation on them. This report was as harmonious as it was unexpected. In every one of the chalk-like deposits to which I have referred he found *fresh-water diatomaceæ.*

From the stratification and horizontality of these deposits, I had been fully assured that they were thrown down from great bodies of water that filled the spaces separating the more elevated portions of the interior basin, and here I had evidence that this water was fresh. Since that time a vast amount of evidence has accumulated to confirm the general view then taken of the changes through which the surface of this portion of our continent has passed. From Southwestern Idaho and Eastern Oregon I have now received large collections of animal and vegetable fossils of great variety and interest. Of these the plants have been, for the most part, collected by Rev. Thomas Condon, of the Dalles, Oregon, who has exposed himself to great hardship and danger in his several expeditions to the localities in Eastern Oregon, where these fossils are found. The plants obtained by Mr. Condon are apparently of Miocene age, forming twenty or thirty species, nearly all new and such as represent a forest growth as varied and luxuriant as can be now found on any portion of our continent.

The animal remains contained in these fresh-water deposits have come mostly from the banks of Castle Creek, in the Owyhee district, Idaho. The specimens I have received were sent me by Mr. J. M. Adams, of Ruby City. They consist of the bones of the mastodon, rhinoceros, horse, elk and other large mammals, of which the species are probably in some cases new, in others identical with those obtained from the fresh-water Tertiaries of the "Bad Lands" by Dr. Hayden. With these mammalian remains are a few bones of birds and great numbers of the bones and teeth of fishes. These last are cyprinoids allied to *Mylopharodon*, *Milocheilus*, etc., and some of the species attained a length of three feet or more. There are also in this collection large numbers of fresh-water shells of the genera *Unio*, *Corbicula*, *Melania* and *Planorbis*.* All these fossils show that at one

* One of the most common is a species of *Tiara* closely resembling an East Indian one, while the genus no longer exists in this continent.

period in the history of our continent, and that geologically speaking quite recent, the region under consideration was thickly set with lakes, some of which were of larger size and greater depth than the great fresh-water lakes which now lie upon our northern frontier. Between these lakes were areas of dry land covered with a luxuriant and beautiful vegetation, and inhabited by herds of elephants and other great mammals, such as could only inhabit a well-watered and fertile country. In the streams flowing into these lakes, and in the lakes themselves, were great numbers of fishes and mollusks of species, which, like the others I have enumerated, have now disappeared. At that time, as now, the great lakes formed evaporating surfaces, which produced showers that vivified all their shores. Every year, however, saw something removed from the barriers over which their surplus water flowed to the sea and, in the lapse of time, they were drained to the dregs. In the Klamath lakes, and in San Francisco, San Pablo and Suisun bays, we have the last remnants of these great bodies of water; while the drainage of the Columbia lakes has been so complete, that in some instances, the streams which traverse their old basins have cut two thousand feet into the sediments which accumulated beneath their waters.

The history of this old lake country, as it is recorded in the alternations of strata which accumulated at the bottoms of its water basins, will be found to be full of interest. For while these strata furnish evidence that there were long intervals when peace and quiet prevailed over this region, and animal and vegetable life flourished as they now do nowhere on the continent, they also prove that this quiet was at times disturbed by the most violent volcanic eruptions, from a number of distinct centres of action, but especially from the great craters which crowned the summit of the Sierra Nevada. From these came showers of ashes which must have covered the land and filled the water so as to destroy immense numbers of the inhabitants of both. These ashes

formed strata which were, in some instances ten or twenty feet in thickness. At other times the volcanic action was still more intense, and floods of lava were poured out which formed continuous sheets, hundreds of miles in extent, penetrating far into the lake-basins, and giving to their bottoms floors of solid basalt. When these cataclysms had passed, quiet was again restored, forests again covered the land, herds dotted its pastures, fishes peopled the waters, and fine sediments abounding in forms of life accumulated in new sheets above the strata of cooled lava. The banks of the Des Chutes River and Columbia afford splendid sections of these lake deposits, where the history I have so hastily sketched may be read as from an open book.

But, it will be said that there are portions of the great central plateau which have not been drained in the manner I have described. For, here are basins which have no outlets, and which still hold sheets of water of greater or less area, such as those of Pyramid Lake, Salt Lake, etc. The history of these basins is very different from that of those already mentioned but not less interesting nor easily read. By the complete drainage of the northern and southern thirds of the plateau through the channels of the Columbia and Colorado, the water surface of this great area was reduced to the tenth or one-hundredth part of the space it previously occupied. Hence, the moisture suspended in the atmosphere was diminished in like degree, and the dry hot air, sweeping over the plains, licked up the water from the undrained lakes until they were reduced to their present dimensions. Now, as formerly, they receive the constant flow of the streams that drain into them from the mountains on the east and west, but the evaporation is so rapid that their dimensions are not only not increased thereby, but are steadily diminishing from year to year. Around many of these lakes, as Salt Lake, for example, just as around the margins of the old drained lakes, we can trace former shore lines and measure the depression of the water level. Many of these lakes

of the Great Basin have been completely dried up by evaporation, and now their places are marked by alkaline plains or "salt flats." Others exist as lakes only during a portion of the year, and in the dry season are represented by sheets of glittering salt. Even those that remain as lakes are necessarily salt, as they are but great evaporating pans where the drainage from the mountains—which always contains a portion of saline matter—is concentrated by the sun and wind until it becomes a saturated solution and deposits its surplus salts upon the bottom.

The southern portion of the great central table land—that which has been denominated the Colorado Plateau—is almost without mountain barriers or local basins, and we, therefore, find upon it fewer traces of ancient lakes, though they are not entirely wanting. It is apparent, however, that this high plateau, which stretches away for several hundred miles west of the Rocky Mountains, was once a beautiful and fertile district. The Colorado draining then, as now, the western ranges of the Rocky Mountains, spread over the surface of this plateau, enriching and vivifying all parts of it. When it reached the western margin of the table land, however, it poured over a precipice or slope five thousand feet in height, into the Gulf of California, which then reached several hundred miles farther north than now. In process of time the power developed by this stupendous fall cut away the rock beneath the flowing water, and formed that remarkable gorge to which I have already referred. This gorge is nearly one thousand miles in length and from three thousand to six thousand feet in depth, and is cut through all the series of sedimentary rocks from the Tertiary to the granite, and has worn out the granite to a depth of from six hundred to eight hundred feet. Just in proportion as the Colorado deepened its channel, the region bordering it became more dry, until ultimately the drainage from the mountains passed through it in what may be even termed "underground channels," and contributed almost nothing

to the moisture of the surrounding country. The reason why the walls of this cañon stand up in such awful precipices of thousands of feet is, that the perennial flow of the stream is derived from far distant mountains; almost no rain falls upon its banks, and when any portion of the bordering cliff has passed beyond the reach of the stream, it stands almost unaffected by atmospheric influences.

On the east of the Rocky Mountains lies the country of the "plains," a region not unlike in its topography to the great plateau of the West, but differing in this: that it is not bordered on the east by a continuous mountain chain; that it slopes gently downward to the Mississippi, and that its eastern half has been so well watered that the valleys have been made broad and all its topographical features softened down. In former times, however, the topographical unity now conspicuous on the plains did not exist, and the surface was marked by a series of great basins which received the flow of water from the Rocky Mountains and formed lakes, less numerous, it is true, but of greater extent than those of the far West. The northern portion of the eastern plateau has been Dr. Hayden's chosen field of exploration for many years; a field he has well tilled, and from which he has obtained a harvest of scientific truth which will form for him an enduring and enviable monument.

Among the most interesting researches of Dr. Hayden in this region, are the studies he has made of the deposits which have accumulated in these great fresh-water basins. The story he has written of his explorations of this district has been so well and fully told that I shall not attempt to repeat it. Suffice it to say, that the series of fresh-water basins discovered by Dr. Hayden in the country bordering the Upper Missouri have proved to be as rich in new and interesting forms of animal and vegetable life as any that have been found upon the earth's surface. The vertebrate remains collected by Dr. Hayden have been studied, described and illustrated by Dr. Liedy, and the splendid monograph which

he has published of these fossils, forms a contribution to paleontology not second in value or interest to that made by Cuvier in his illustrations of the fossils from the Paris basin; nor to that of Falconer and Cautley, descriptive of the fossils of the Sewalik hills of India.

The scarcely less voluminous and interesting collections of fossil plants made by Dr. Hayden have been placed in my hands for my examination. Of these, the first instalments were described and drawn some years since as a contribution to the report of Colonel W. F. Reynolds, U.S.A., a report not yet published by the Government. The descriptions, however, were printed in the Annals of the Lyceum of Natural History of New York, vol. ix, 1868.

The general conclusions drawn from a study of this portion of Dr. Hayden's collections as regards the floras of the Tertiary and Cretaceous periods, the topography and climate of the interior of the continent, form a part of my contribution to Colonel Reynolds' report. Since that report was written, however, very large additions have been made to our knowledge of our later extinct floras, by collections of fossil plants made in different portions of the western part of our continent by Dr. Hayden, Mr. Condon, Dr. Le Conte and myself; and also by the collections made by Mr. W. H. Dall and Captain Howard in Alaska, and by several explorers on the continent of Greenland.

Deferring for the present a comparison of the plants derived from strata of similar age in these widely separated localities, and the inferences deducible from them as regards the physical geography of our continent, I will say that the flora and fauna of the lake deposits on both sides of the Rocky Mountains apparently belong to one and the same geological age, and tell the same story in regard to the topography, climate, conditions and development of animal and vegetable life. There is this striking difference, however, perceptible at the first glance between the fresh-water Tertiaries of the east and west. In Oregon, Idaho and

Nevada, volcanic materials have accumulated in the lake basins to a much greater extent than east of the Rocky Mountains; and we have abundant evidence that during the Tertiary period the western margin of the continent was the scene of far greater volcanic activity than we have any record of in the Rocky Mountain belt.

The deposits formed by the lake basins of the Upper Missouri region are shales, marls and earthy limestones, with immense quantities of lignite, but with almost no traces of volcanic products. The number of fossil plants and animals is much greater there than farther West; and we have, in these deposits, proof that during unnumbered ages this portion of the continent exhibited a diversified and beautiful surface, which sustained a luxuriant growth of vegetation and an amount of animal life far in excess of what it has done in modern times. This condition of things existed long enough for hundreds and even thousands of feet of sediment to accumulate in the bottoms of extensive fresh-water lakes. These lakes were gradually and slowly diminished in area by the filling up of their basins and by the slow wearing away of the barriers over which passed their gently flowing, draining streams. Since the deposition of the fresh-water Tertiaries, which occupy the places of the old lakes, great changes have taken place in the topography of this region by the upheaval of portions of the Rocky Mountain ranges. In some localities these lake deposits are found turned up on edge and resting on the flanks of the mountains which border the plains on the west. It is certain, however, that much of the Rocky Mountain belt existed anterior to this date. We have in these, and many other facts that might be cited, proofs of the truth of the assertion I have elsewhere made that these great mountain chains, though existing at least in embryo from the earliest paleozoic ages, have, since then, been subject to many and varied modifications—that they have been, in fact, hinges upon which the great plates of the continent have turned—lines

of weakness where the changes of level experienced by the continent have been most sensibly felt.

It is a somewhat remarkable fact that the collections of fossil plants made by Dr. Hayden from different localities differ so much among themselves. In every newly discovered plant-bed he has obtained more or less species of which we before had no knowledge, and it is even true that between some of his collections there are no connecting links. It is also true that much of the material he has collected has not yet received the study it needs. From these facts it will be seen that much yet remains to be done before the great interval of time during which this series of fresh-water Tertiaries accumulated can be divided into definite periods, and before we can venture to affirm that a flora of any epoch had such or such a botanical character and, therefore, this or that average annual temperature. Some interesting facts came out, however, at once in the examination of these materials; to these I will briefly refer.

In the beginning of the Cretaceous age, North America, as we know, presented a broad land surface, having a climate similar to the present, and covered with forests consisting, for the most part, of trees belonging to the same genera with those that now flourish upon it. In the progress of the Cretaceous age, the greater part of the continent west of the Mississippi sank beneath the ocean, and the deposits made during the later portions of the Cretaceous age contain a vegetation more tropical in character than that which had preceded it. It seems probable that at this time the lands which existed as such, west of the Mississippi, were islands of limited extent, washed by the Gulf Stream, which apparently had then a course north and west from the Gulf of Mexico to the Arctic Sea.

The earlier Tertiary epochs were, however, marked by an emergence of the continent and a gradual approach to previous and present conditions. This is indicated by the fact that the oldest Tertiary deposits (Eocene?) contain a flora

less like the present than is that of the Miocene or Middle Tertiary. In this category of older deposits with a more tropical flora, I would place the Green River Tertiary beds, those of Mississippi studied by Lesquereux, and those of Brandon, Vermont.

In the Miocene age, the continental surface was broader, the lake basins of the West contained only fresh water, and the land surface was covered with a vegetation very much like that of the present day; a number of Miocene species still existing. The climate of the continent in the Miocene age was much milder than now. Fan-palms then grew as far north as the Yellowstone River, and a flora flourished in Alaska and on Greenland as varied and as luxuriant as now grows along the fortieth parallel. At this time there must have been some sort of land connection between our continent and Europe on the one hand and Asia on the other. The flora of all these regions was essentially the same, and a large number of plants were common to the three continents. In this age the mammalian fauna of our continent exhibited the same remarkable development that it did in Europe and Asia; and over our western plains roved herds of great quadrupeds rivalling in number and variety those that have struck with wonder and surprise every traveller in South Africa.

This state of things seems to have continued through the Pliocene age and up to the time when the climate of the continent was completely revolutioned by the advent of the "Ice period." The change which took place at that time was such as taxes the imagination to conceive of, as much as it taxes the reasoning powers to explain.

We have seen that in the Middle Tertiary age the climate of Alaska and Greenland was that of New York and St. Louis at present. In the next succeeding period, the glacial epoch, the present climate of Greenland was brought down to New York, and all the northern portion of the continent wrapped in ice and snow. This change was undoubtedly

gradual (for nature does not often "turn a corner"), but it is plain that it must have resulted in the gradual driving southward of all the varied forms of animal and vegetable life that were spread over the continent to the Arctic Sea. When glaciers reached as far south as the fortieth parallel it is evident that a cold-temperate climate prevailed in Mexico, and that only in the south of Mexico would the average annual temperature have been what it was previously in the latitude of New York. We must conclude, therefore, that the herds of mammals which once covered the plains of the interior of North America were forced by the advancing cold into such narrow limits in Southern Mexico that nearly all were exterminated. Plants bore their expatriation better; inasmuch as a tree, even of the most gigantic size, will live upon the space occupied by its roots provided the climatic conditions are favorable; while one of the larger mammals would require at least a thousand times this space for its support. As a consequence, we find the present flora of our continent much more like that of the Miocene than is our fauna, though the change to which I have referred seems to have been fatal to quite a number of the most abundant and interesting of our Miocene forest trees. Of these, the *Glyptostrobus* may be taken as an example. This was a beautiful conifer which, in Miocene times, grew all over our continent and over Northern Europe. In the change to the glacial period, however, it was exterminated, both there and here, yet continued to exist in China—where a Miocene colony from America had taken root—and it is growing there at the present time. This great ice-wedge which came down from the north separated very widely many elements in our Miocene flora which have never since been re-united, so that when the storm had passed and better days had come, and the Mississippi Valley and the Atlantic States were re-possessed by the descendants of the Tertiary plants, they were still separated, by many thousand miles, from their brethren which had formerly crossed the now submerged bridge of

Behring's Straits; and thus the two kindreds have been growing, and flowering, and seeding, and dying in each colony far beyond the reach of the other, and developing their peculiarities each in its own way from generation to generation. When now we come to compare the present flora of China and Japan with that of the eastern half of our continent we find the strongest proofs of their intimate relationship. Many of the species are identical, while others are but slightly changed and, on the whole, the differences are less than such as have grown out of separation in human kindred colonies in an infinitely shorter period.

Among the great mammals that formerly inhabited our continent but such as are now extinct, there were some which seem to have bid defiance to the changes I have detailed. These were particularly the mastodon and elephant, both of which were probably capable of enduring great severity of climate. The mammoth we know was well defended from the cold by a thick coat of hair and wool, and was probably capable of enduring a degree of cold as severe as that in which the musk-ox now lives. We know that both these great monsters — the elephant and mastodon — continued to inhabit the interior of our continent long after the glaciers had retreated beyond the upper lakes, and when the minutest details of surface topography were the same as now. This is proven by the fact that we not unfrequently find them embedded in peat in marshes which are still marshes where they have been mired and suffocated. It is even claimed that here, as on the European continent, man was a cotemporary of the mammoth, and that here as there, he contributed largely to its final extinction. On this point, however, more and better evidence than any yet obtained is necessary before we can consider the cotemporaneity of man and the elephant in America as proven. The wanting proof may be obtained to-morrow, but to-day we are without it.

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Among the great mammals that formerly inhabited our continent but such as are now extinct, there were some which seem to have bid defiance to the changes I have detailed. These were particularly the mastodon and elephant, both of which were probably capable of enduring great severity of climate. The mammoth we know was well defended from the cold by a thick coat of hair and wool, and was probably capable of enduring a degree of cold as severe as that in which the musk-ox now lives. We know that both these great monsters — the elephant and mastodon — continued to inhabit the interior of our continent long after the glaciers had retreated beyond the upper lakes, and when the minutest details of surface topography were the same as now. This is proven by the fact that we not unfrequently find them embedded in peat in marshes which are still marshes where they have been mired and suffocated. It is even claimed that here, as on the European continent, man was a cotemporary of the mammoth, and that here as there, he contributed largely to its final extinction. On this point, however, more and better evidence than any yet obtained is necessary before we can consider the cotemporaneity of man and the elephant in America as proven. The wanting proof may be obtained to-morrow, but to-day we are without it.

The pictures which geology holds up to our view of North America during the Tertiary ages, are in all respects but

one, more attractive and interesting than could be drawn from its present aspects. Then a warm and genial climate prevailed from the Gulf to the Arctic Sea; the Canadian highlands were higher, but the Rocky Mountains lower and less broad. Most of the continent exhibited an undulating surface; rounded hills and broad valleys covered with forests grander than any of the present day, or wide expanses of rich savannah over which roamed countless herds of animals, many of gigantic size, of which our present meagre fauna retains but a few dwarfed representatives. Noble rivers flowed through plains and valleys, and sea-like lakes broader and more numerous than those the continent now bears diversified the scenery. Through unnumbered ages the seasons ran their ceaseless course, the sun rose and set, moons waxed and waned over this fair land, but no human eye was there to mark its beauty or human intellect to control and use its exuberant fertility. Flowers opened their many-colored petals on meadow and hill-side, and filled the air with their fragrance, but only for the delectation of the wandering bee. Fruits ripened in the sun, but there was no *hand* there to pluck, nor any speaking tongue to taste. Birds sang in the trees, but for no ears but their own. The surface of lake or river was whitened by no sail, nor furrowed by any prow but the breast of the water fowl; and the far-reaching shores echoed no sound but the dash of the waves, and the lowing of the herds that slaked their thirst in the crystal waters.

Life and beauty were everywhere; and man, the great destroyer, had not yet come, but not all was peace and harmony in this Arcadia. The forces of nature are always at war, and redundant life compels abundant death. The innumerable species of animals and plants had each its hereditary enemy, and the struggle of life was so sharp and bitter that in the lapse of ages many genera and species were blotted out forever.

The herds of herbivores — which included nearly all the

genera now living on the earth's surface, with many strange forms long since extinct—formed the prey of carnivores commensurate to these in power and numbers. The coo of the dove and the whistle of the quail were answered by the scream of the eagle; and the lowing of herds and the bleating of flocks come to the ear of the imagination, mingled with the roar of the lion, the howl of the wolf, and the despairing cry of the victim. Yielding to the slow-acting but irresistible forces of nature, each in succession of these various animal forms has disappeared till all have passed away or been changed to their modern representatives, while the country they inhabited, by the upheaval of its mountains, the deepening of its valleys, the filling and draining of its great lakes, has become what it is.

These changes which I have reviewed in an hour seem like the swiftly consecutive pictures of the phantasmagoria or the shifting scenes of the drama, but the æons of time in which they were effected are simply infinite and incomprehensible to us. We have no reason to suppose that *terra firma* was less firm, or that the order of nature, in which no change is recorded within the historic period, was less constant then than now. At the present rate of change—throwing out man's influence—a period infinite to us would be required to revolutionize the climate, flora and fauna, and there is no evidence that changes were more rapid during the Tertiary ages.

Every day sees something taken from the rocky barrier of Niagara; and, geologically speaking, at no remote time our great lakes will have shared the fate of those that once existed at the far West. Already they have been reduced to less than half their former area—and the water level has been depressed three hundred feet or more. This process is likely to go on until they are completely emptied.

The cities that now stand upon their banks will, ere that time, have grown colossal in size, then gray with age, then have fallen into decadence and their sites be long forgotten,

but in the sediments that are now accumulating in these lake-basins will lie many a wreck and skeleton, tree-trunk and floated leaf. Near the city sites and old river mouths these sediments will be full of relics that will illustrate and explain the mingled comedy and tragedy of human life. These relics the geologist of the future will probably gather and study and moralize over as we do the records of the Tertiary ages. Doubtless he will be taught the same lesson we are, that human life is infinitely short, and human achievement utterly insignificant. Let us hope that this future man, purer in morals and clearer in intellect than we, may find as much to admire in the records of this first epoch of the reign of man, as we do in those of the reign of mammals.

THE CHINESE IN SAN FRANCISCO.

BY REV. A. P. PEABODY, D.D.

THE Chinese form from a seventh to a fifth part of the entire population of San Francisco, and are seen in considerable numbers in all parts of California. They mingle with no other race; they learn or profess to know enough and only enough of the English tongue to transact their necessary business with their employers; and in San Francisco they live almost wholly in their own crowded quarters, which constitute in all respects a city by itself.

In the street they are the cleanest and neatest of people. Every man and boy has his *queue* of hair, as long as himself, nicely wrapped in silk braid, and generally rolled round the head. Their principal garment is a dark blue, close-fitting frock. Their shoes are of silk or cloth, with felt soles.

Their houses are dirty beyond description. Scores and even hundreds of them are sometimes huddled together in the same building, with blankets for their only beds, and

almost their only furniture. In these houses their simple cooking is performed in the long halls into which their apartments open, over furnaces, with no legitimate outlet for the coal-smoke, which leaves its black and greasy deposit half an inch thick on the ceiling and walls. I went into several of their fashionable restaurants, and found them hardly less filthy than their lodgings, yet with a marvellous variety of complicated and indescribable delicacies, which a year's income of the establishment might have tempted me to touch, but certainly not to taste.

Their provision-shops contain little except pork, and that, seldom in a form in which it would be recognized by an unpractised eye. Every part of the swine, even the coagulated blood, is utilized; and the modes in which the various portions of the beast are chopped, minced, wrapped in intestines, dried almost to petrifaction, commingled with nauseous seasonings, pique the curiosity as much as they offend the nostrils of the American observer.

Their theatres offer an amazing spectacle. Their performances commence early in the forenoon, and last till midnight. Their plays are said to be historical, and they are often continued for several days. The scenery is simple, cheap, and gaudy, and is never changed. The costumes are splendid, with a vast amount of gilding and of costly materials, but inexpressibly grotesque, and many of the actors wear hideous masks. The orchestra consists of a *tom-tom* (which sounds as if a huge brass kettle were lustily beaten by iron drumsticks), and several of the shrillest of wind-instruments. The noise they make may be music to a Chinese ear, but it consists wholly of the harshest discords, and each performer seems to be playing on his own account, and to be intent on making all the noise he can. This noise is uninterrupted, and the actors who are all men (men playing the female parts in costume), shout their parts above the din in a falsetto recitative, monotonous till toward the close of a speech, but uniformly winding up with a long-drawn, many-

quavered whine or howl. The performance is for the most part literally acting. A crowned king or queen is commonly on the stage, and almost always comes to grief. Parties of armed men meet on the stage, hold sham-fights, kick each other over, and force the sovereign into the melée. Then a rebel subject plants both his feet in the monarch's stomach, knocks him down, and himself falls backward in the very act. Thus the fight goes on, and gathers fury as its ranks are thinned, till at length the whole stage is covered with prostrate forms, which lie for a little while in the semblance of death, then pick themselves up, and scud off behind the scenes. The actors live in the theatre, though they might seem to have no living-room. I went into the principal theatre one morning, before the actors, who had been performing until a late hour, had arisen; and I found them lying in one of the passage-ways in several tiers of holes, so nearly of the size of the human body that they could only have wormed themselves in feet first.

Gambling is one of their passions. There are numerous gambling-houses where the playing goes on through the whole day and night, with an orchestra like that of the theatre, enriched by a single female singer, whose song seems a loud, shrill, ear-piercing monotone, so horrible as almost to compel the belief that the Chinese ear must have as unique a structure as if it belonged to a different species from ours.

The Chinese exercise, with marvellous skill, all the mechanical arts and trades, and have as large a variety of shops as the Americans, with wonderfully rich assortments of goods, including works in wood-carving, ivory and filigree, which can nowhere be surpassed in delicacy and beauty.

Their temples or josh-houses, are small upper rooms, with hideously grinning idols, overlaid with tinsel, and covered with tawdry ornaments, on an elevated platform at the extremity of the apartment. Before these idols a dim lamp is always burning, and a table is spread for votive offerings, which are generally cups of tea or fruits. These apartments

are in the buildings maintained by the Chinese Emigrant Aid Societies as reception-houses and hospitals,—vile dens as we should deem them, but, it is said, fully level with a Chinaman's notions of repose and comfort.

These people are by no means unintelligent. It is said that there are none of them who cannot read, write, and cast accounts; and there are among them some men of high education, polished manners, large business, and friendly, yet never intimate relations with their brother-merchants.

There is a mission-house, with a school and a chapel; but the missionary, an intelligent man and an indefatigable worker (by the way, my guide and mentor among the theatres and gambling-houses, in which he seemed very much at home, on the principle of becoming all things to all men), told me that he had gained a firm hold on very few; that he found it almost impossible to keep a small congregation together through a very short service, though many came in to listen for a little while; and that the slightest disturbance in the street, even the passing of a hand-organ, would instantly empty his chapel.

These Chinamen are generally without their families; the numerous women that live in their quarters being with very few exceptions persons of bad character. The men come to this country with the purpose of remaining but a few years; and if they die, their bodies are embalmed, and sent home for burial, Chinese corpses sometimes forming a vessel's entire freight.

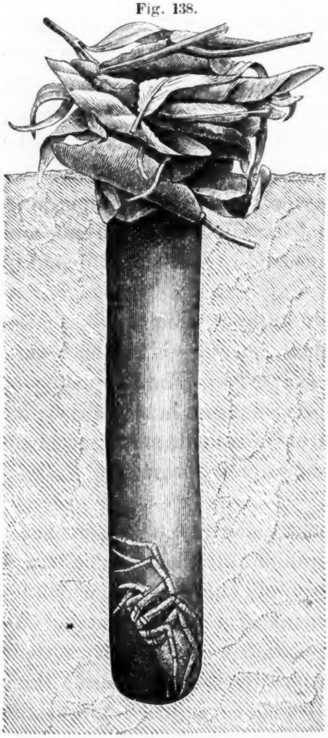
The Chinese question I cannot undertake to discuss here. Suffice it to say that, in my opinion, all that can be hoped from the Chinese is the supply of cheap labor which is needed for the rapid development of a new country. As to making these people citizens who will even prize their rights, still more exercise them judiciously, or changing their older and to them satisfying type of civilization into the Anglo-Saxon Christian type, — this is utterly beyond probability or hope. If the Chinese are to be Christianized, it

must be on their own soil, and with no invasion of their ancestral habits, except the engrafting upon them of the morality of the New Testament.

THE LYCOSA AT HOME.

BY J. H. EMERTON.

Fig. 138.



Nest of Lycosa.

Last spring Mr. J. A. Lintner noticed on the sandy hills west of Albany, N. Y., a number of holes about half an inch in diameter, each surrounded by a ring of sticks and bits of leaves loosely fastened together by fine threads. A few days afterward (May 6), I carefully opened several of these holes and found in the bottom of each a large spider, a Lycosa. The holes were from six to eight inches deep and lined with a delicate web, which near the top was stout enough to be separated from the sand, forming a silken tube attached to the ring of chips around the mouth of the hole. When the holes were opened the spiders lay still in the bottom and allowed themselves to be taken out without attempting to escape. The sand at the bottom

of the holes was of a grayish color, but there were no remains of insects and no cast skins of the spider. Before opening the holes we sounded them with straws and tried to provoke the spiders to come out, but they took no notice of it. The drawing represents the ring of leaves and sticks, a section of the tube, and the spider at the bottom, all of the natural size.

LICHENS UNDER THE MICROSCOPE.

BY H. WILLEY.

THE Lichens, though among the lowest, are also among the most abundant and widely distributed orders of plants. They are the earliest to cover the naked rocks with vegetation (though none, that we are aware, have been found in a fossil condition), and by their decay, to prepare a soil on which more highly organized plants can flourish. In the Arctic zone some species are so abundant as to furnish the reindeer with the food necessary for his subsistence, and are even used as fodder for cattle and swine, and are said to increase the quantity of milk. Recently they have been used for the manufacture of brandy—a very poor use to put them to—and were formerly much employed in dyeing. Hoffman, in his work on the uses of lichens, gives plates of over seventy-five tints obtained from them. But the recent scientific discoveries in this art, have greatly diminished their use for this purpose. Some were formerly used for medical purposes, frequently in accordance with the old doctrine of signatures. *Peltigera canina* was supposed to cure hydrophobia; *Sticta pulmonaria*, the consumption, etc. But they are now considered of little, if any importance, in medicine.

Arctic travellers have found in Umbilicaria, called *tripe de roche*, a poor and bitter substitute for food, when nothing

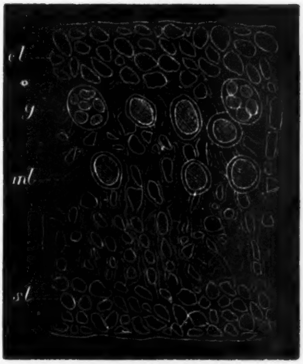
better could be obtained; and in Sweden bread has been made of the reindeer lichen in times of famine.

Lichens abound, also, in the temperate zone, especially in the mountains and the moist regions of the coast. Nearly three hundred species have been found in this vicinity (New Bedford). The number of known species, according to the most recent estimate (Krempelhueber, 1865), is about five thousand. They are to be met with everywhere. In swamps the trees are festooned with the pendulous *Usnea*. The foliaceous Parmelias, Stictas, etc., cover their trunks. The rocks and stones are everywhere covered with their spreading crusts. Some species grow on rocks covered with fresh or salt water. The brown, or scarlet fruited Cladonias, or "cup mosses," which the French call "herbe du feu" are spread over the earth. Some attain a diameter of two feet or more, while others are so small as hardly to be visible to the naked eye. Many of them are brilliantly colored, and exceedingly beautiful. They may be collected at any season of the year, are easily preserved, and their study, though not common among our botanists, owing, in a great degree, to the want of books on the subject in this country, and the necessity of using the microscope in order to become properly acquainted with them, is full of interest and instruction.

In the natural system of plants the lichens belong to the Cryptogamous, or flowerless series, which includes the ferns, mosses, algæ, and fungi. They rank below the mosses, having no distinct stem or foliage, but bearing their fruit on a foliaceous, shrubby, or crustaceous expansion, called a thallus, whence they are sometimes called Thallophytes. They have affinities on the one side with the algæ, and on the other with the fungi, and by some botanists have been included under one or the other of these orders. A recent writer, Schwendener, has propounded the theory that they are a compound plant, the thallus being a true alga, and the apothecium a fungus; but to this theory no true lichenist will be likely to assent.

The distinctive features of lichens consist in their having a thallus containing peculiar green cells, called gonidia, and in their spores being contained in asci, or spore-cases. In the latter particular the ascomycetous fungi resemble them, but these are always destitute of gonidia. A bluish reaction of the gelatinous substance of the apothecia is also characteristic of most lichens, though in some it is brown or red. In the fungi the reaction with iodine is yellow, except in a very few instances, where it is blue.

Fig. 139.



Section of thallus of *Theloschistes parietina*; *cl*, cortical layer; *g*, gonidia; *ml*, medullary layer; *sl*, inferior layer.

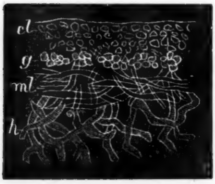
In order to investigate more closely the structure of the lichens, let us take any foliaceous lichen, *Theloschistes parietinus* (Fig. 139), for instance, the common orange-colored wall lichen, which occurs everywhere on stones and trunks; and having inserted a portion of the thallus in a slit made in a piece of soft cork, with a razor slice off as thin a cross-section as possible, and put it on a slide, with a drop of water, beneath a piece of thin glass, under the lens of our microscope. We shall see that it is composed entirely of cellular tissue, differing in this respect from those plants which have a vascular tissue. The upper surface, *cl*, we shall perceive to consist of a layer of cells composed of this tissue. Next beneath this is a stratum of round, greenish yellow bodies, *g*, called gonidia; then a stratum of elongated cells or filaments, *ml*, crossing each other in various directions, constituting the medullary layer; and lastly another row of cells forming the lower sur-

Fig. 140.

Collema leptaleum; *a*, section of thallus; *b*, moniliform gonidia.

face, *sl*, and from which proceed the slender fibres by which the plant is attached to the matrix on which it grows. These four layers make up the thallus of lichens. In some genera, as Collema (Fig. 140), the upper cellular layer is wanting, and the gonidia lie close to the surface; in others, as Peltigera, the lower is deficient, and bundles of long fibres proceed immediately from the medullary layer. These are very conspicuous and curious in *Parmelia colpodes* (Fig. 141). They constitute the hypothallus, which forms the substratum on which the other parts of the thallus are built up.

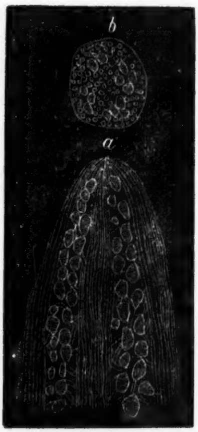
Fig 141.



Parmelia colpodes; *cl*, cortical layer; *g*, gonidia; *ml*, medullary layer; *h*, hypothallus.

In the fruticulose lichens, which bear some resemblance to the stem of a plant, the thallus is more or less rounded, and the gonidia are arranged around the medullary layer as an axis. In Usnea (Fig. 142) the thallus is solid, and the centre is composed of a mass of compact filaments lying parallel to the axis. In other genera it is hollow, or composed of loose filaments. In some genera, as Lichena, the medullary filaments, instead of running parallel to the axis, diverge from the centre to the circumference. In many crustaceous lichens the thallus consists of hardly more than a collection of gonidia, sometime buried beneath the bark, and of few filamentary elements. In these the hypothallus often forms a black border around the margin of the thallus.

Fig. 142.

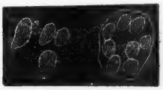


Usnea barbata; *a*, longitudinal section of thallus; *b*, cross-section of the same.

The gonidia constitute the peculiar characteristic of the lichen thallus, and are present in all true lichens, their presence being almost the only mark by which some can be

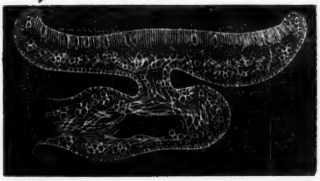
distinguished from fungi. There are some parasitic plants, consisting only of apothecia, which grow on the thallus of other lichens, called by Massalongo and Koerber, Pseudolichens, which are considered by some as lichens, by others as fungi. Most of them give the characteristic blue reaction with iodine. In examining a section of a young specimen of one of these, *Scutula Wallrothii* Tul. (*Biatora Heerii* Hepp), which grows on the thallus of *Peltigera canina*, I have seen a stratum of true gonidia underlying the apothecia, and extending around it. Some of these parasites are doubtless lichens, while others must be relegated to the ascomycetous fungi.

Fig. 143.



Granula gonima of *Sticta fuliginosa.*

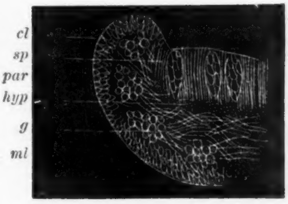
Fig. 144.



Section of apothecium of *Theloschistes parietina.*

The gonidia are either of a greenish yellow color, as mentioned above, as in Physcia, Parmelia, and the greater number of lichens; or of a bluish green, as in Collema, Peltigera, some Stictas, etc. These latter are called granula gonima, or collegonidia. In Collema they are strung together like a chaplet of beads, and are called moniliform (Fig. 140, *b*). In some genera they spring from the end of thalline filaments, in others they are grouped together, enveloped in a transparent gelatinous substance, and surrounded by a thin membrane (Fig. 143). In Synalissa both kinds of gonidia occur. They frequently burst into mealy excrescences, called soredia, on the surface of the thallus, and have the faculty of multiplying by self-division and of propagating the plant,

Fig. 145.



Portion of same more enlarged: *cl*, cortical layer; *sp*, spore-cases; *par*, paraphyses; *hyp*, hypothecium; *g*, gonidia; *ml*, medullary layer.

and in this way many lichens on which apothecia rarely or never occur, are multiplied. In some Verrucarias there are small gonidia, called hymenial gonidia, included in the hymenium.

The gelatinous substance which is found in the thallus is called lichenine. It is of a starchy nature. In many crustaceous lichens, oxalate of lime is present in considerable quantities, and may be easily recognized by its octahedric crystals. Phosphate of lime, salt, sugar, oil, with various peculiar acids, also occur, but not in great abundance.

Having thus viewed the principal features of the lichen thallus, let us now turn our attention to its organs of fructification. On looking at the lichen (Theloschistes) already selected, we shall see its surface covered with small round disks of nearly the same color as the thallus. These are the apothecia (Fig. 144), and contain the spores, the reproductive organs of the plant. Making a thin perpendicular section of one of these, and placing it under oui lens, we shall see that it is surrounded by a margin containing gonidia like the thallus. The interior (Fig. 145) is composed of a mass of parallel filaments, called paraphyses, among which are the asci, or spore-cases. This interior portion is called the hymenium. That part which contains the paraphyses and asci is called the thalamium, and the portion below it, the hypothecium.

Those lichens whose fruit has an open disk, are called gymnocarpous. The margin of the disk is called the exciple. When formed from the thallus, and containing gonidia, it is called a thalline exciple; when otherwise, a proper exciple. The thalline exciple is usually pale, yellow, brown, red, or of the same color as the thallus, though it often blackens. The proper exciple is either black, as in Lecidea, or colored, as in Biatora. But in many lichens with a thalline exciple, it often assumes a biatorine form. The exciple is sometimes double, as in Gyalecta. The color of the disk varies greatly, being flesh-colored, yellow, red, brown, or

black. In some species, as *Nephroma arctica* and *Parmelia perforata*, the apothecium attains a large size. In Cladonia it is borne on the summit of a hollow stalk, called a podetium; in Calicium on a slender solid stem. In the Graphides, or "written" lichens, the apothecia are elongated and narrow, branched or stellate, and bear a rude resemblance to written characters.

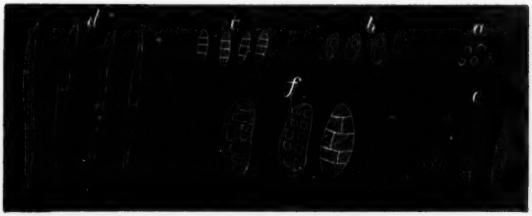
Fig. 146.

Spore-case of *Theloichistes parietina*, with spores.

In many genera, such as Verrucaria, the apothecia are closed, and these are called angiocarpous. These apothecia are usually black, conical, with a small opening at the summit. Their covering is sometimes called the perithecium. But there is no fixed line of demarcation between the gymnocarpous and the angiocarpous lichens.

The paraphyses are sometimes long and thread-like, and

Fig. 147.



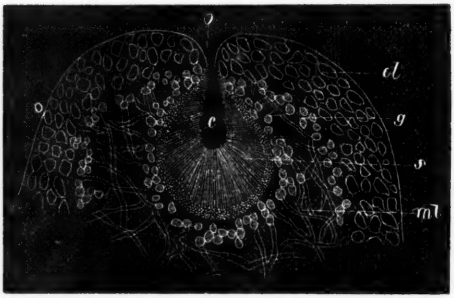
Spores.	*a*, simple colored	spore	of	*Calicium phæocephalum.*
	b, diblastish	"	"	*Ramalina calicaris.*
	c, tetrablastish	"	"	*Buellia vernicoma.*
	d, acicular	"	"	*Biatora rubella.*
	e, fusiform	"	"	*Collema flaccidum.*
	f, muriform	"	"	*Buellia petræa.*

easily separated, sometimes short and closely agglutinated, and, as in Arthonia, are sometimes entirely wanting. In this genus the exciple is also wanting. The paraphyses and spore-cases are generally colored blue, sometimes red or brown, by a solution of iodine.

The spore-cases, which lie among the paraphyses, are sacks usually of an oblong or club-shaped form, sometimes lanceo-

late or globose. In some genera, as Calicium, they disappear early, and the spores then appear to be free. But they are usually persistent, and a little pressure is required to separate the parts and bring out the spores. In the plant under examination there are eight of them in each spore-case. This is the usual number. But many species have one, two, four, sixteen, or more, or even several hundred spores in each spore-case. The spores differ greatly in size, form and color. In Theloschistes they are colorless, of an oval form (Fig. 146), with a small cavity at each end, sometimes connected by a small canal, and measure from twelve to sixteen thousandths of a millimetre in length. In other species they are of a brownish yellow, or a deep brown approaching black. The smallest spores are hardly two thousandths of a millimetre in diameter, while the largest are nearly two-tenths of a millimetre in length. In form they are globose, oval, elliptical, fusiform, needle-shaped, etc. (Fig. 147). Many spores are divided by one or more transverse partitions, and these again sometimes by perpendicular ones. The former are called *di-tetra-pleio-*, or poly-blastish; the latter muriform, and spores like those of Physica, polar-bilocular. Their great variety of form and color renders them most interesting objects under the microscope, and they are of

Fig. 148.



Section of Spermogonea of *Theloschistes parietina*. *cl*, cortical layer; *g*, gonidia; *o*, ostiolum; *c*, cavity; *s*, sterigmata; *ml*, medullary layer.

Fig. 149.

Sterigmata and spermatia of the same.

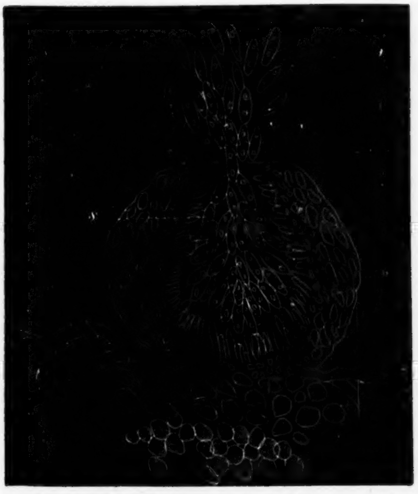
great importance in the determination of species, so that the study of lichens cannot now be successfully or thoroughly prosecuted without an acquaintance with them. Their general form and color being constant in each genus and species, they have, as Professor Tuckerman observes (Lichens of California), "added a new content to the conception of species." While their study opens fresh difficulties and perplexities to the student, it affords him a deeper insight into the inscrutable mysteries of nature, who, whatever we may strive to ascertain, ever holds some secrets in reserve which are beyond our grasp.

Fig. 150.

Spermatia.

In its earliest stages the spore-case appears filled with small globular granules, in which lines of division appear, and the spores gradually assume their regular form and number. The spores are at first colorless and simple, and their internal divisions and changes of color may be seen in all gradations in the same hymenium. They frequently remain filled with a mass of oil globules. They are sometimes arranged in a linear

Fig. 151.



Section of pycnide of *Biatora Heeri. s*, stylospores; *t*, thallus of *Peltigera canina*.

series in the spore-case, sometimes irregularly grouped, and sometimes spirally twisted around a central (ideal) axis. When ripe they are expelled from the spore-case by the pressure of the paraphyses, which when moistened, absorb water copiously. Many observations have been made as to the manner of the development of the thallus from the spore, but the matter is still involved in a good deal of obscurity.

Fig. 152.

Portion of pycnide of *Biatora Heerii* more highly magnified, showing the stylospores.

On the thallus of most lichens are to be seen a number of small black dots, either scattered irregularly over its surface, or along the margin. These are the spermogonea (Fig. 148), and they contain, in great numbers, the spermatia, which are extremely minute, cylindrical, or needle-shaped bodies, situated on the extremities of simple or branched filaments, called sterigmata (Figs. 149, 153). Their forms appear to be constant in each species, but are much less diverse than those of the spores, and they are always colorless. They have been supposed to be the male organ of reproduction, but nothing is certainly known of their functions. Nylander, who attaches much importance to the spermatia in his Synopsis, distinguishes five forms of them. 1st, the acicular slightly swollen at one end, as in Usnea; 2d, acicular slightly swollen near the extremity, as in Evernia; 3d, straight acicular or cylindrical, as in most Lecanoras; 4th, bowed acicular, or cylindrical, as in some Lecanoras; 5th, ellipsoid or oblong, as in Calicium, which last, he says, approach rather too near the short cylindrical spermatia. There are no spherical spermatia. But he is not fortunate in attempting

Fig. 153.

Spores (*a*), sterigmata and spermatia (*b*) of *Biatora Heerii*.

to apply these distinctions, and it seems difficult to render them of any great systematic value. Leighton, who has described and figured the spermatia of a large number of lichens, has failed in many instances to recognize the differences in form indicated by Nylander, especially in regard to the first two forms. and points out a great confusion in the application of Nylander's idea in his Prodromous and Synopsis in regard to the spermatia of Platysma (Cetraria). In figure 150 (*a*, spermatia of *Pyrenula lactea* Mass.; *b*. *Verrucaria epigœa* Pers.; *c*, *Synalissa phylliscina; d*, *S. phæococca* Tuck.; *e*, *Lecanora athrocarpa* Duby; *f*, *Parmelia colpodes* Tuck.; *g*, *Cetraria ciliaris* Ach.; *h*, *Placodium camptidium* Tuck.), we give a few additional illustrations of the different forms of spermatia. A slight but distinct crackle is almost invariably heard on crushing the spermogonia under the thin glass, which seems peculiar to these organs. Besides the spermogonia, there are also other small bodies, resembling them in external appearance, called pycnides (Fig. 151), but containing spore-like bodies called stylospores (Fig. 152), on the extremities of short filaments. They are often septate. Their office is unknown, and they are of comparatively infrequent occurrence.

REVIEWS.

THE EARED SEALS.*—Up to the year 1866, comparatively little attention had been paid to the systematic relations *inter se* of the seals, and in that year, Dr. John Edward Gray, in the "Catalogue of the Seals and Whales in the British Museum," adopted essentially the same classifica-

* On the Eared Seals (*Otariadæ*), with detailed descriptions of the North Pacific species, by J. A. Allen. Together with an account of the habits of the northern fur seal (*Callorhinus ursinus*), by Charles Bryant. [1 pl. 108 pp., 3 pl. 31. exp.] Bulletin of the Museum of Comparative Zoology [etc.]. Vol. II. No. 1.

The copy which we owe to the kindness of the author, is further illustrated by two photographic plates of *Zalophus Gillespii*.

tion which he had presented in 1850, in his catalogue of the seals — a singularly unnatural one, based chiefly on the number and development of the teeth; all the Pinnipeds were regarded as forming a single family, divided among five sub-families, namely: —

A. Grinders two-rooted; [etc.] *

a. cutting teeth 4 [above]; 4 [below] [etc.] *Stenorhynchina.*

b. " " 6 [above]; 4 [below] [etc.] *Phocina.*

B. Grinders with single root (except the two hinder grinders of *Halichœrus*).

c. Ears without any conch; [etc.].

* Muzzle large, truncated, simple; canines large; grinders lobed, when old, truncated. *Trichechina* (with *Trichecus Rosmarus* and *Halichœrus!*)

** Muzzle of the male with a dilatable appendage; cutting teeth 4 [above] 2 [! below]; [etc.] *Cystophorina.*

d. Ears with a subcylindrical distinct external conch; [etc.] *Arctocephalina.*

* Only the prime contrasted characters are noticed here; the others are often applicable only to a portion of the groups diagnosed.

If classification is really intended to represent the natural relations of organized beings, as determined by the sum of their structural agreements, and the subordination of the respective groups differentiated, a more unfortunate classification than that noticed could scarcely be devised; if even it is only regarded as a means to enable us to ascertain the name of a certain form, it is a decided failure; *i. e. Halichœrus* (of the second prime division), having the "grinders with single root (*except the two hinder*)," not being distinguished, even by Gray's own diagnosis, from *Lobodon* of the *Stenorhynchina* (first prime division), which has only "the first, second, and third front upper grinders single-rooted, [the rest *two hinder*] two-rooted!" Like inconsistencies prevail, but why, in the name of science and common sense may we ask, is *Halichœrus* separated from those forms which it so much resembles, to be combined with the Walrus, to which it is so very unlike, when even a diagnosis has to be explained away to admit of such a freak! The chief modifications in the arrangement of 1866, compared with that of 1850, are the introduction of the genera *Pagomys, Halicyon*, (the latter based on intangible characters,) and *Callorhinus.*

In the same year, 1866, appeared a "Prodrome of a Monograph of the Pinnipeds, by Theodore Gill," in the Proceedings of the Essex Institute (V, pp. 1-13), in which those animals were distributed among three families (*Phocidæ, Otariidæ*, and *Rosmaridæ*), equivalent to the three subfamilies recognized by Turner, and the *Phocidæ* were divided into three sub-families, distinguished by important osteological characteristics previously unnoticed by systematists. In the *Otariidæ*, five genera were recognized, of which the types were the only species mentioned.

This article was rapidly succeeded by a number of memoirs, chiefly on the Otariids, two by Gray and two by Peters being published in the same year. The former, after a first passionate outburst of anger, finally accepted as valid the three families just noted, and, like Peters, adopted the genera of Otariids first defined in the Prodrome (*i. e. Eumetopias* and

Zalophus), raised to generic rank two additional groups named as sub-genera by Peters, and ended by proposing genera for every recognized species of the family, and distributing them among five sub-families. The extreme to which differentiation was carried may be judged from the fact that Mr. Allen has reduced two of his genera to one species, and was strongly inclined to reduce three others to a second species. Those sub-families in the main agreed with the genera defined in the "Prodrome of the Pinnipeds," but were rendered unnatural by the combination — in face of the characters used as diagnostic — of *Arctophoca* (a sub-division of *Arctocephalus*) with *Eumetopias*, and by the association of *Phocarctos* (a form inseparable from *Otaria*) in the "*Arctocephalina*." As an example of the mode of differentiation, the following diagnoses will suffice.

"*Zalophus*. Grinders large and thick, in a close uniform series. South America."

"*Nerphoca*. Grinders large, thick, all equal, in a continuous uniform series. Australia."

As will be perceived, the same feature is indicated simply by a slightly different phraseology, save as to the locality. But even the alleged character of locality is erroneous, for *Zalophus* has never been found in South America, and its type is an inhabitant of the North Pacific only, *i. e.* California and Japan!

The chief and most valuable information published after the "Prodrome," and up to the year 1870, was contributed by Dr. Wilhelm Peters, and to that accomplished zoologist we are indebted for the first reliable coördination of external and osteological characters — a task that was found to be impossible with the material possessed by the author of the "Prodrome."

Much information had also accumulated as to the distribution, habits, and external characteristics of the various species of *Otariidæ*, and excellent figures of the skulls of several species had been published. It was with these additional facilities that Mr. J. A. Allen proceeded to the investigation of the North Pacific species of the family, and incidentally of the classification of the entire group. He has, like his immediate predecessors, admitted the validity of the family called by him "*Otariadæ*," and has admirably contrasted the characteristics of the pelvis and hind limbs of those animals, with the corresponding parts of the Phocids; the species of Otariids are distributed among five genera corresponding to those established in the "Prodrome," and of which our author remarks that "these appear to be natural groups, of true generic rank, and properly restricted; and, after a careful examination of the subject, ... they appear to [him] to include all the natural genera of the family."*

These five genera are considered by Mr. Allen as separable among two sub-families, the author remarking (p. 22) "that if the *Otariadæ* constitute a group entitled to family rank, — and the so-called sub-families of the

* Allen, op. cit., p. 38.

Phocidæ have truly a sub-family value, —the *Otariadæ* must be considered as divisible into two sub-family groups, of which the hair seals constitute one and the fur seals the other." Reviewing the previous sub-divisions into tribes or sub-families by Gray, and the misappropriation of sub-family names derived from the typical genera, he adds that in view of this confusion the name *Trichophocinæ* * is proposed for the hair seals, and *Oulophocinæ* † for the fur seals, in allusion to the different character of the pelage in the two groups." To the *Trichophocinæ*, are referred the genera *Otaria*, *Eumetopias*, and *Zalophus*; to the *Oulophocinæ*, the genera *Arctocephalus* and *Callorhinus*.

Mr. Allen has derived the characters for his sub-families, solely from the nature of the pelage, the size and form of the entire animal, the length of the ears, the length of the toe-flaps of the hinder limbs, and the number of molars. His definitions are as follows:—

"Sub-family I. *Trichophocinæ*.

Without under-fur; size large and form robust; ears short and broad; molars either 6 [above] 5 [below] 5 [above] 5 [below]=12 [above] 10 [below] or 5 [above] 5 [below] =10 [above] 10 [below]."

"Sub-family II. *Oulophocinæ*.

With thick under-fur; size smaller; form more slender, and the ears and the toe-flaps of the hinder limbs much longer than in *Trichophocinæ*; molars 6 [above] 5 [below] 6 [above] 5 [below]=12 [above] 10 [below]." (Allen l. c., 44.)

We may at once concede the applicability of the distinctions based on the pelage, remarking, however, that the character is not as absolute as might be inferred from the expressions used, for in the hair seals there is the homologue of the under-fur of the fur-seals, and Gray attributes to *Zalophus cinereus*, "young covered with *soft fur*, which falls off when the next coat of fur [hair] is developed." Peters also found a considerable difference in the extent of the under fur in the species of *Arctocephalus*, *A. antarctica* (*Otaria pusilla* Peters) having very thin under hair ("Mit sehr sparsamer Unterwolle"); *A. cinerea*, thicker under-hair ("Mit reichlicherer Unterwolle"), and *A. Falklandica* also thick under-hair ("Haar mit dichter Unterwolle"); the difference between the extremes of those two groups seems thus to be very much reduced, when we take all into consideration.

As to size, the difference seems to be more than reduced to a minimum, and to be degraded to absolute nullity. The length of the skull is the most constant meter, and the following measurements, to all of which Mr. Allen had access, will demonstrate the truth of our criticism. We have in every case taken the measurement of the adult males only, and have reduced all the measurements to millimetres.

1.	Arctocephalus nigrescens, ...	203	Gray.
2.	" Falklandicus, ...	235	Peters.
3.	Callorhinus ursinus, ...	237	Gray.

* θριζ, hair, and φώκη, seal.
† Οὖλος, soft, and φώκη.

4.	Otaria Ulloæ,	238	Peters.
5.	Callorhinus ursinus,	245	Allen.
6.	Arctocephalus antarcticus,	262	Gray.
7.	Zalophus Gillespii (Japonica),	270	Peters.
8.	Callorhinus ursinus,	275	Allen.
9.	Zalophus Gillespii,	279	Gray.
10.	" "	290	Allen.
11.	Otaria Godeffroyi,	300	Peters.
12.	Zalophus Gillespii (Japonica),	310	Peters.
13.	" "	330	Allen.
14.	Otaria jubata,	335	Gray.
15.	Eumetopias Stelleri,	355	Gray.
16.	" "	374	Allen.
17.	" "	385	Allen.

As it may be objected that the skull of *Otaria Ulloæ* was of a female or young, we will at once dismiss that from consideration. But the forms still remaining, and concerning which no objection, it appears to us, can be urged, demonstrate that there is not only no constant difference, but that members of the respective groups traverse the limits assigned thereto, some individuals of *Oulophocinæ* being larger than some individuals of the *Trichophocinæ*, *Zalophus* being admitted as one of the latter. It is further to be added that the "form more slender" of the former, implies a greater relative total length for those animals than the head alone would indicate, and thus the inapplicability of the diagnosis is still further enhanced.

As to the character derived from the comparative robustness or slenderness, the following measurements by Mr. Allen, of the hair and fur seals of Alaska, show the following proportions:*—

	Unmounted.	Mounted	Skull.	Ratio of skull to length of male skin.
Callorhinus ursinus (2,923),		2,470	245	I.-X. 20-245
" " (2,922),	2,311	2,390	275	I.-VIII. 190-275
Eumetopias Stelleri (2,920),	2,750	2,790	374	I.-VII. 300-374
" " (2,921),	2,896	3,010	385	I.-VII. 315-385

When we thus become cognizant of the comparatively slight differences between the two members of the family observed, when too, we notice the range of variations in one of the species, and when we reflect that such difference may be created by the mode of preparation of skins, and that other forms appear to be intermediate, to say the least, the character becomes very intangible.

The length of the ears is the next character noticed; the following measurements will illustrate the relative lengths in millimetres.

Otaria,	15-20	Peters.	Eumetopias,	35-37	Allen.
Zalophus,	15-20?	Peters.	Arctocephalus,	30-40	Peters.
Eumetopias,	30	Peters.	Callorhinus,	35-50	Allen.

These measurements, by Mr. Allen, are from the *same individuals*, before

* No data are given concerning the ratio of the girth to the length, and no very appreciable and constant differences appear to exist, although there is said to be considerable difference in such respects in the same individual at different seasons.

and after mounting, the ears appearing shorter when mounted. We thus learn at once to distrust and be cautious respecting such characters, even admitting their value. But in view of these tables, and the conclusions we have already reached concerning the size, we are compelled to ask, where are the differences — even proportionate? Be it remembered that no differences of form have been referred to, nor has the reviewer by autopsy been able to convince himself of the existence of any of moment.

One other character remains; in *Oulophocinæ* "the toe-flaps of the hinder limbs much longer than in *Trichophocinæ*." The statement is perfectly applicable, whatever may be our estimate of its value, if only *Callorhinus* and *Eumetopias* are taken into consideration, but *Otaria* itself offers an intermediate condition. There is no difference claimed as to dentition, as the alternatives for the *Trichophocinæ* indicate.

Mr. Allen, we trust, will pardon us, in view of the facts now made prominent, if we refuse to consider the alleged differences as indicative of sub-family value, if only for the reason that they are not trenchant; but we must add that even had they been absolute, we should have been extremely doubtful as to the propriety of assigning them such a taxonomic value.

But if we have been obliged — and most unwillingly we have — to dissent from Mr. Allen in his view of taxonomic values, we rejoice to testify to our concurrence with him in the main, and if Mr. Allen will simply reject *Zalophus* from the company of the other hair seals, we will at once admit that he has made an important advance in the appreciation of the relations, *inter se*, of the members of the family; the comparative relation between *Otaria* and *Eumetopias* appears indeed to be more intimate than previous observers had suspected, and equally intimate as contrasted with those just named is the relationship between the genera of the fur seals. But between both forms and *Zalophus*, the hiatus appears to be almost equally wide and impassable, although perhaps less between it and the typical hair seals. If any prime sub-division of the Otariids is to be made, and if the skull is a correct index, it should, in our judgment, be made into one group, composed of all its members save *Zalophus*, while that group should be isolated afar. All the species, except of that genus, agree in having a more or less decurved and swollen muzzle, and a deep sagittal seam, or groove, between the low ridges indicating the limits of the muscular attachments. *Zalophus*, on the contrary, has a narrow and regularly attenuated muzzle, which is straight or even slightly concave, and instead of a sagittal seam has a much elevated and trenchant crest; these characters are supported by peculiarities of the post-orbital lobes, the nasal channel, the sinus of the bony palate, the pterygoid hamuli, and the dentition. *Zalophus*, as Mr. Allen has well remarked, "so far as the skull is concerned, is the most distinct generic form of the *Otariadæ*, it being thoroughly distinct from all the others" (p. 68). We may add that we know of no indications, from other sources, which belie

this evidence of isolation. But while we would thus insist on the isolation of *Zalophus*, we would not consider it as entitled to rank other than as an aberrant genus (*i.e.* in comparison with the more numerous existing forms) of a homogeneous family. Far different, in our opinion, are the relations between the members of that family and the groups which have been distinguished as sub-families in the Phocids,* and which we are happy to learn meet with Mr. Allen's approbation.

Availing ourselves now of the data that have accumulated up to the present time, and which have been so well digested by Mr. Allen, we believe that the relations of the Otariids may be expressed by the following synoptical table, in which only the most obvious and distinctive characters are introduced.

I. Skull with a more or less decurved front rostral profile, and with a sagittal groove from which are reflected the low ridges indicating the limits of the temporal muscles.
  A. Pelage with under-fur: molars normally 6 [above] 5 [below] 6 [above] 5 [below]; hinder feet with swimming membranes produced much beyond the toes, and moderately incised.
    a. Snout much decurved above, and abbreviated, its length being less than the longitudinal diameter of the orbits, *Callorhinus.*
    b. Snout moderately declining above, and moderate in length, exceeding the longitudinal diameter of the orbit, . . . *Arctocephalus.*
  B. Pelage without defined under-fur.
    a. Molars above 6-6; the last little remote from the preceding and in a line with, or in advance of the transverse maxillo-palatine suture; bony palatal margin much nearer the pterygoid hamuli than the teeth; hinder feet with swimming membrane much produced and deeply incised. . . . *Otaria.*
    b. Molars above 5-5; the last remote from the preceding, and behind the transverse maxillo-palatine suture; bony palatal margin nearer to teeth than to pterygoid hamuli; hinder feet with swimming membrane produced little beyond the toes and moderately incised, ... *Eumetopias.*
II. Skull with a straight or incurved fronto rostral profile, and with a solid, thin, and much elevated sagittal crest, ... *Zalophus.*

Although we are not inclined to place much stress on the sequence of forms when so many gaps remain unfilled, and when the unknown might reverse the opinion that we have with more or less reason derived from some acquaintance with the seen, we are disposed to believe that the preceding approximates correctness, and to believe that *Zalophus* is the most generalized form, *Eumetopias* next, and *Callorhinus* the most specialized. If it were absolutely necessary to express the various categories of subordination by names, we would have to designate I. and II. as contrasted, and then I. (A). and I. (B). as representing a nearer degree of relationship, but such a system, especially when the genera are very numerous, becomes too complicated, and is of really little or no use. We

* These sub-families, though bearing the same name as Dr. Gray imposed on artificial groups, are entirely differently limited.

do not speak of taxes on the memory, for memory has nothing to do with the existence of natural groups, although some persons are in the habit of objecting to names because, forsooth, they tax the memory.

With respect to species, Mr. Allen carries conservatism to an extreme. In the case of doubtful species — at least of those which have tangible characters, but the value of which may be dubious — some naturalists refer such at once to species which they appear, in their judgment, to most resemble, while others — probably most—retain them with reserve, awaiting future information. Of the former school Mr. Allen is an ardent disciple, and finding a certain range of variation in some known form, he concludes that analogous variations are only of like value; the inference is by no means a perfectly safe one, though it may be best in *proposing* specific names, to be somewhat influenced thereby. In the present family, at least ten species have been admitted by one of the most accomplished and judicious naturalists (Professor Peters) of Europe, after autopsy. Three such species are considered by Mr. Allen, who had never seen them and was only guided by analogy, as variations of one; *Otaria jubata*, *O. Ulloæ*, and *O.* (*Phocarctos*) *Hookeri*,* being referred to *O. jubata* extended; and three other species unhesitatingly admitted by those who have examined them, are admitted as very doubtful, *i. e.*, *Arctocephalus Falklandicus*, *A. cinereus* (Gray), and *A. antarcticus*. It may be that Mr. Allen is correct; there are doubtless reasons for his belief, but, in our judgment, the interests of science are better subserved by retaining the doubtful forms as distinct, till observation has demonstrated their character; by retaining them as distinct, an incitement is furnished to their collection and investigation, while if they are merged as synonymous with others, their identity is lost; it is assumed that their degradation was correct, and if finally proved to be distinct, it has too often happened that they have been re-introduced into the system under new names, the recollection of their former distinction having been lost, and thence it is that in after years the nomenclature is again disturbed by the revival of the unjustly buried names. It is to be feared that some of the species which Mr. Allen has doomed to annihilation will yet arise and assume a healthy stability.

A few words as to the relations of the family. Mr. Allen, treating of the primary groups of the Pinnipeds, remarks (p. 21), that "believing that they have a higher value than a sub-family value, I adopt for the present the classification elaborated by Dr. Gill, in his Prodrome, which is, it seems to me, the most natural arrangement of the Pinnipeds that has been proposed. Gill's arrangement places the *Otariadæ* between the *Phocidæ* and *Rosmaridæ*.* The *Otariadæ* are evidently the highest, though they seem intermediate in general features between the earless seals and

* Since the transmission to the printer of the copy of this review, a number of the "Anales del Museo publico de Buenos Aires" has come to hand in which the discovery of the *O. Hookeri* at the mouth of the Rio Parana (op. cit. I. 461) is announced.

the walruses. Their affinities, as they appear to me, may be indicated as follows: —

OTARIADÆ,

"ROSMARIDÆ,

PHOCIDÆ.

"The evidences of the superiority of the *Otariadæ* over the *Phocidæ*, consist mainly in that modification of their general structure, and especially of the pelvis and posterior extremities, by means of which they have freer use of their limbs, and are able to move on land with considerable rapidity; the *Phocidæ*, on the other hand, move with great difficulty when out of the water. But the higher rank of the former is also indicated by their semi-terrestrial habits, the scrotal position of the testes, and in the nearer approach in general features to the terrestrial Carnivores, especially in the more posterior position of the acetabula. Most of these modifications are, however, nearly equally shared by the *Rosmaridæ*, indicating, likewise, that their true position is above that of the majority of the *Phocidæ*."

Like considerations of structure induced the author of the "Prodrome" to adopt the arrangement commended, but without reference to that metaphysical rank to which Mr. Allen seems to refer. High and low in zoology are often very ambiguous terms. So far as Mr. Allen means the generalized, by high, and by lower, the more modified types, we perfectly agree with him, for the Otariids seem indubitably to be the least removed in structure from that stock which has diverged from the old feral stem and culminated into the existing Pennipeds; nearly equally plain does the evidence appear that the Walrus is in general a type which possesses more of the primitive characters of the stock than do the Phocids, although it exhibits some remarkable teleological adaptations. But such a connection of the term high would indicate a belief in progressive degradation — a Hibernicism which we are probably not the first to use. Even in this sense, as an abstract question, we have no objection to the employment of the term low, for there seem to be too many proofs of the existence of such cases to doubt. But Mr. Allen leaves us in uncertainty as to whether he shares with the few scientists a belief in metaphysical species and subordination, or, with the many, interprets appearances as indicative of facts. In the former case there would be no basis for argument, but if we still call low, in comparison with the gressorial carnivores, the Pinnipeds and the whales, believing in their evolution from the same stock as the former, it is only because we connect, with adaptation for aquatic life, the idea of degradation. How far this may be correct, we are not at present called upon to discuss. It may be here stated that if the author of the "Prodrome," in a treatise on the Pinnipeds alone, placed the Otariids in the middle, because they were the most generalized, and the other types departed therefrom in different directions, he would not feel barred, in a general scheme of the mammals, from placing them, for the same reason, next to the still more generalized group

In this connection it may be recalled that while in the monogamous Pinnipeds, or those living in small communities, there is little difference in size between the males and females, in the social species, or rather those of which the males have harems, the males are vastly larger than the females. *Macrorhinus*, of the Phocids, and all the Otariids belong to the latter category. The difference between the sexes would be readily explained by Mr. Darwin on the principle of natural selection. It is evident that the larger and more vigorous males would be the eventual possessors of the females, and the disproportion of the sexes would in lapse of time culminate, till it had reached a proportion when obvious mechanical difficulties would more than balance the advantages resulting from superior size and vigor, and when, therefore, farther disproportion would be arrested. It may be added that the like disproportion of the sexes in the forms above enumerated, furnishes not the slightest evidence of more intimate primordial affinity, for like causes would in each special case, such as this, produce like effects.

We have already lingered so long over the systematic portion of Mr. Allen's work that we are perforce obliged to omit any observations on the habits or physiological relations of the species, but the work is replete with information on the subject contributed by Captain Bryant respecting the fur-seal (*Callorhinus ursinus*), and judiciously edited, with notes and comparisons with the habits of other members of the family, by Mr. Allen.

And finally, cordially thanking Mr. Allen for his most valuable contribution, and the Museum of Comparative Zoology, under Professor Agassiz's superintendence, for its publication, we close by a recapitulation of its most noteworthy elements, namely: — A nearly complete résumé of the later literature on the subject, and discussion of the value of the respective contributions, enabling him who would follow up the investigation to refer at once to the proper authorities; an excellent contrast of the skeletal characters of the Otariids and Phocids; a coördination of external and internal characters for the genera, and the approximation of the related genera; detailed descriptions and measurements of the Alaskan species; and, finally, in company with Captain Bryant, copious information respecting their habits, and comparison thereof with those of other species. — THEODORE GILL.

INJURIOUS INSECTS.* — In this contribution to applied entomology, we find new observations relating to insects injuring the apple-tree, cherry, cranberry vine, currant, raspberry, oak, pine, certain ornamental shrubs, garden vegetables and hot-house plants. The apple-bud moth (*Grapholitha oculina*), so injurious in Eastern New England, is described. The larva is a little brown caterpillar which eats the buds in May. It is difficult to kill it without also injuring the tree itself. It also injures the buds

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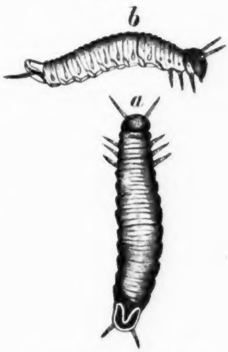
* Injurious Insects, New and Little Known. By A. S. Packard, jr., M. D. [From the Massachusetts Agricultural Report, 1870.] 8vo, pp. 31. With a plate and wood-cuts.

and crumples the leaves of the cherry, and especially the pear. A minute moth is also described as mining the leaves of the apple, a single leaf sometimes containing five or six larvæ. It is a Micropteryx (*M. pomivorella* n. sp.), allied to the European *M. calthella*, though about half its size. This is the only species of this interesting genus yet found in America. Of the two moths infesting the cherry, the v-marked tortrix (*Tortrix V-signatana* n. sp.) has been raised from the cherry by Mr. F. W. Putnam. The other is a beautiful Coleophora (*C. cerasivorella* n. sp.). Four insects infesting the cranberry vines are mentioned. One of these is the yellow cranberry worm (*Tortrix vacciniivorana* n. sp.), of the New Jersey cranberry fields, while the habits of the cranberry weevil (Pl. 6, fig. 10, enlarged; 10*a*, larva, enlarged), are described from the observations of Mr. W. C. Fish, who has paid more attention than any one else to the insects infesting the cranberry. Two insects not before known to feed on the currant, are the *Chærodes transversata* of Walker, and *Halia wavaria*, a species introduced from Europe, where it has long been known to feed on the gooseberry.

Fig. 154.



Larva of a species of Lyda.

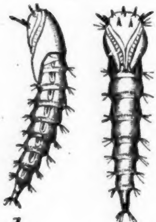
The raspberry is attacked by a beetle (*Byturus unicolor* Say, Pl. 6, fig. 12, enlarged), which eats the fruit buds, and makes long slits in the leaves during June. Of forest insects, the many-teethed Priocycla (*P. bilinearia* n. sp.), is a span worm feeding on the oak. The pine Paraphia (*P. piniata* n. sp.); the pine Zerene (*Z. piniaria* n. sp.), and pine Parennomos (*P. piniata* n. sp.), have been found feeding on the pine in Canada by Mr. W. Saunders, to whom our entomologists are much indebted, among other articles, for his descriptions of the larvæ of many of our butterflies and moths. Besides these pine insects, the singular saw-fly larva of a species of Lyda (Fig. 154), which has been found on the Austrian pine in a garden in Salem, deserves mention. It is a reddish olive green worm, with a pale reddish head, and two appendages to the end of the body like its antennæ.

A species of the Snout moth, of the genus Botys (*B. syringicola* n. sp.) has been found by Mr. Angus of New York, boring the pith of lilac bushes, and it is stated in this connection that Mr. Angus has also found a clear winged moth (*Ægeria syringæ* Harris) to be often destructive to lilacs.

Of interest to gardeners is an account of the bean weevil (*Bruchus granarius* of Linnæus, Pl. 6, fig. 8, bean containing several grubs; 8*a*, pupa). This is the well known and very destructive bean weevil of Europe, concerning which Mr. Angus writes from West Farms, N. Y., to the author: "I send you a sample of beans which I think will startle you

if you have not seen such before. I discovered this beetle in the kidney or bush beans a few years ago, and they have been greatly on the increase every year since. I might say much on the gloomy prospect before us in the cultivation of this important garden and farm product if the work of this insect is not cut short by some means or other. The pea Bruchus is bad enough, but this is worse."

Fig. 155.

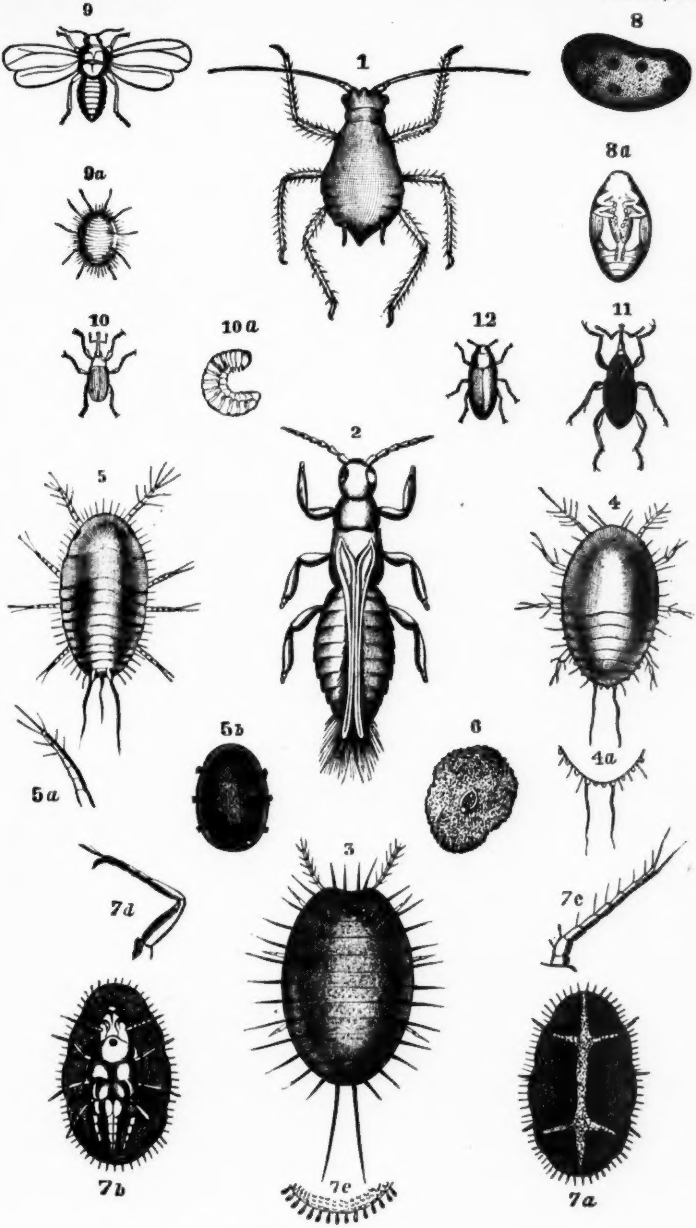


Pupa of Robber-fly.

Another insect is brought to the notice of farmers, the corn Sphenophorus (*S. zeæ* Walsh, Pl. 6, fig. 11), of which Mr. R Howell of Tioga County, New York, writes June 14, 1869: "This is the fourth year they have infested the newly planted corn in this vicinity. The enclosed specimens were taken on the 11th instant. I presume that they have been in every hill of corn in my field. They pierce the young corn in numerous places, so that each blade has from one to six or eight holes of the size of a pin, or larger, and I found a number last Friday about an inch under ground hanging to young stalks with much tenacity. When very numerous every stalk is killed. Some fields two or three years ago were wholly destroyed by this insect. The habits of a robber-fly (*Proctacanthus Philadelphicus* fig. 155, pupa), which burrows in the sand of the shores of Plum Island, Mass., are noticed, together with those of the large horse fly (*Tabanus atratus*, fig. 156, pupa), which in its early stages lives in garden mould. Among plant house insects is noticed the white scale bark louse (*Aspidiotus bromeliæ*, Pl. 6, fig. 6, magnified; 4, young magnified; 4*a*, end of body still more enlarged). It is often destroyed by a minute chalchid fly, Coccophagus(?). Boisduval's fern bark louse (*Lecanium filicum* Pl. 6, fig. 7*a*, scale enlarged seen from above; 7*b*, the same, seen from beneath, and showing the form of the body surrounded by the broad flat edge of the scale; 7*c*, an antenna, enlarged; 7*d*, a leg, enlarged; 7*e*, end of the body, showing the flattened hairs fringing the edge), is common on hot-house plants, as also the Platycerium bark louse (*Lecanium platycerii* n. sp. Pl. 6, fig. 5, magnified; 5*a*, an antenna enlarged). and the plant house coccus (*C. adonidum* Pl. 6, fig. 3, magnified); the plant house aleurodes (*A. vaporarium* of Westwood, Pl. 6 fig. 9, enlarged; 9*a*, pupa enlarged), is more common perhaps than one would suppose. It lives out of doors on tomato leaves and we found it not uncommon, in September, on strawberry plants on the grounds of the State Agricultural College, at Amherst. The list of hot-house insects is completed by one of the most injurious of all, the minute thrips (*Heliothrips hæmorrhoidalis*), from Europe, Pl. 6, fig. 2, greatly magnified, which by its punctures, causes the surface of the leaf affected to turn red or white, while at times the entire leaf withers.

Fig. 156.

Pupa of Horse-fly.



PACKARD, ON INJURIOUS INSECTS.

NATURAL HISTORY MISCELLANY.

BOTANY.

Fertilization of Salvia by Humble Bees. — Mr. Meehan's statements "On Objections to Darwin's Theory of Fertilization through Insect Agency," at the late meeting of the American Association for the Advancement of Science, an abstract of which is given in the October Number of the American Naturalist, are at such variance with my own observations on the same subject, that I cannot allow them to pass unchallenged. Mr. Meehan affirms that the humble bee does not enter the corolla of the Salvia to obtain the honey, but "bores a hole on the outside" for that purpose. He says, after describing the structure of the flower — "The principle is perfect. *But no insect is seen to enter.*" This statement is certainly not in accordance with facts. I have again and again observed the conduct of the humble bee on the Salvia; and I affirm that a large majority of the bees *do* enter the corolla, and that the anthers rest on the back of the insect exactly in the way that Mr. Meehan says they ought to rest. It is true that some of the bees do cut the tube of the corolla to get the honey. This, however, is only done by those bees which are *too large* to get into the flower. — E. H. T., *Hindsbury, Delaware Co., Penn., Oct.* 15, 1870.

Motion in the Leaves of Rhus toxicodendron. — Botanical writers tell us that sections of a leaf of *Schinus molle*, thrown in water, have a peculiar jerking motion. Under the name of "Australian Myrtle," I have received seeds from California, which prove to be this plant. The leaves have the motions described. I thought perhaps our own representatives of this order (*Anacardiaceæ*) might present the same phenomenon. I find that this is the case with *Rhus toxicodendron.* Small sections of a leaf leap about in water, but not with the same force as do those of the *Schinus Rhus aromatica* though so nearly allied, presents, *to me*, no motion. I have tried *Rhus glabra*, *R. copallina* and *R. typhina*, but find no motion in any but in the one before named — the common "poisoning." A friend to whom I have suggested it, however, tells me that his gardener finds that at "some hour in the day" these also will leap about. The *Schinus* and *Rhus toxicodendron* with me exhibit their saltatorial feats at any and all times. — Thomas Meehan.

Bur Grass. — I enclose a plant that is very annoying to farmers on the eastern shore of Maryland. I am not botanist enough to determine its place. The natives call it "Sand Burr." Will you be kind enough to say something in the Naturalist about it? — John W. Nott.

[Cenchrus, Hedge-hog or Bur-grass, is peculiar for a general resemblance to our Couch or Quitch-grass, and in its habits is equally regarded

with aversion by the farmers. But this latter is a Northern grass, not found at the South, while the Bur-grass is to be found only beyond the limits of New England; according to Dr. Lapham, from Wisconsin to Minnesota; and in the Middle and Southern States, according to other observers. The specimen sent to us by Mr. Nott is *C. echinatus* Muhlenburg (*Descriptio Uberior Graminum*, p. 51) and figured by Plunkenet (*Phytographia* tab. 92–3). It is described by Dr. Chapman in his "Flora of the Southern United States," p. 578; and another species, the *C. tribuloides*, which grows on the seashores of Delaware, Carolina, etc., known as the Cockspur or Bur-grass, is also familiar to farmers, and much dreaded. As much as we detest the Couch-grass of our northern farms, we are to rejoice in the absence of these spiny and thorny spiked and burred-grasses in our northern soils. In some sections where the land is light, the Couch-grass makes a nutritious fodder and hay, being freely eaten by horses and cows; but we suspect that these sagacious animals would not care to digest the flowers and seeds of the "Sand Burr," although the leaves and stems of *C. echinatus* appear tender and abundant, and we can easily understand that it is very annoying where it naturally grows. — J. L. Russell.]

Wolffia in Blossom. — I have just found (August 28th, 1870) the *Wolffia Columbiana* Karsten, flowering abundantly in a pool at Sandwich, Ontario, on the Detroit River. I enclose specimens. I discovered this station for it more than a year ago; but hitherto have failed to find the flowers till now. Untold millions of these tiny plants covered the surface of the water hiding it completely, and lying *en masse*, at least three-quarters of an inch thick. We find it, also (though not fertile), some miles higher up the river, at Connor's Creek, Michigan, but nowhere else along the shores. Though Gray says "flowers and fruit not seen," it has, I think, been found once in flower in the Catskills. The delicate white flowers disappear soon after taking it from the water; but on placing some, next day, in my aquarium, the little plants at once "righted themselves," and the flowers almost instantly reappeared, expanding fresh as ever from the centre of the frond. Last year, in the same pool, it was quite abundant, growing with *Lemna minor* L., which was, however, largely in the majority. Now, I find the Wolffia has almost taken possession of the pool, driving out the Lemna, which is "few and far between," and of a sickly, degraded type. — Henry Gillman, *Detroit, Michigan.*

ZOOLOGY.

Abdominal Sense-organs in a Fly. — While engaged in naming a collection of microscopic preparations of insects mounted on slides by Mr. T. W. Starr of Philadelphia, for the collection of Dr. T. D'Oremieulx of New York, my attention was drawn to a sense-organ situated on the female anal appendages of a species of Chrysopila, allied to *C. ornata*

(Say), a genus of flies allied closely to Leptis. The female appendages are rounded, somewhat spatulate, and of the usual form seen in other species of the genus. The appendage is covered with stiff coarse hairs, about fifty in number, arising from conspicuous, round, clear cells, while the whole surface, as seen under a Zentmayer's 4-10 (A eye-piece), is densely covered with minute short hairs. On the posterior edge of the *upper* side of each appendage is situated a single, large round sac, with the edge quite regular. Its diameter is equal to a third of the length of the appendage on which it is situated. Dense fine hairs, like those covering the appendage, project inwards from its edge. The bottom of this shallow pit is a clear transparent membrane not bearing any hairs. There are no special sense-organs on the antennæ of the same insect.

With these organs, which I suppose to be olfactory in their function, may be compared a very similar single sac situated on the *under* side of the end of the labial and maxillary palpi of a species of Perla, mounted on a slide in the same collection. Its diameter is nearly half as great as the palpal joint itself. Instead of being depressed, the sac in Perla is a little raised, forming a slightly marked, flat tubercle, which is round, slightly ovate, under a 4-10 objective. The surface of the membrane (tympanule of Lespès) is naked. It is strongly probable that this is an olfactory organ, and placed on the under side of the palpi, next to the mouth, so as to enable the insect to select its proper food by its odor, giving an additional sensory function to the palpi of insects. There are no special sense-organs in the antennæ.

Lespès in his note on the auditory sacs, which he says are found in the antennæ of nearly all insects, states that as we have in insects compound eyes, so we have *compound ears*. I might add that in the abdominal appendages of the cockroach we apparently have a *compound nose*. In the palpi of Perla, and the abdominal appendages of Chrysopila the "nose" is simple.

On examination, I have found sense-organs in both pairs of antennæ of *Homarus Americanus*, the Lobster, such as are described by Farre, and also the more rudimentary form of supposed auditory organs in the common spiny Lobster (*Palinurus*) of Key West, Florida. — A. S. P., *Nov.* 30.

Note on the Existence of transversely striated muscular Fibres in Acmæa.— While engaged in the examination of the lingual ribbon of a species of Acmæa (*A.* (*Collisella*) *Bickmorii D.*), brought from Amboyna by Mr. Bickmore, I noticed that, among the fibres adhering to the ribbon, were several longer than the rest and presenting a different appearance. On submitting them to a high power, it was at once evident that this difference in their appearance was due to distinct, well-marked, though exceedingly fine, transverse striæ. The structure of the fibre itself was a simple transparent tube or cylinder with nuclei irregularly disposed at intervals more or less distant. Upon closer examination of other specimens the striated muscles were determined to be the *retractores radulæ*, or the principal, if not the only agents in pulling back

the ribbon. They were evidently voluntary muscles acting with considerable rapidity. It was noticeable that, of all the muscles of the buccal mass, these only exhibited striation. They differed from some of the dorsal muscles of a small shrimp (*Palæmon* sp.), in being more finely striated. I have had no opportunity, as yet, of examining other species, and therefore cannot say whether the phenomenon is constant throughout the genus. This is the fourth class of the Mollusca, including the Molluscoidea, in which striated muscular fibre has been shown to exist; it has been demonstrated in *Polyzoa* (*Eschara*) by Milne-Edwards; in *Conchifera* (*Pecten*) by Lebert; in *Ascidia* (*Salpa* and *Appendicularia*) by Eschricht and Moss; and finally in *Gasteropoda* in the present case.—W. H. DALL.

CEDAR BIRD WITH WAXEN APPENDAGES ON THE TAIL.—I have not seen it mentioned in any work, nor do I think that many are aware that the Cedar bird (*Ampelis cedrorum* Baird) is occasionally, though very rarely, found with the tail decorated with those singular wax-like, really horny tips, which it is well known adorn the wings. I have recently been shown a specimen taken in New York State in which the four middle tail-feathers were heavily tipped with this red wax. I have heard of three other cases in which this occurred, though not so strongly developed. I believe that this beautiful ornament, which is never found in immature specimens, does not appear on the wings till the third year. And it is probable that the tail is not so decorated till a much later period. The specimens here mentioned gave evidence of being unusually old birds.—HENRY GILLMAN, *Detroit, Michigan.*

HABITS OF THE RED-HEADED WOODPECKER.—In the spring of 1869 some *Melanerpes erythrocephalus*, began pecking a hole for a nesting place, at about sixty-eight feet from the ground, in the steeple of one of the churches that is situated in our village. One of our citizens, Mr. J. C. Gibson, in order to put a stop to their operations and prevent the farther disfiguration of the edifice, undertook to kill all the birds he saw engaged in pecking at the hole thus commenced; he kept up his deadly assaults upon them until this spring, when his absence from home stopped his attacks upon them; he informs me that he killed in all twenty-two or twenty-three birds that had been engaged in the work; during his absence a pair took possession of the unfinished work, completed the nest, and are now engaged in rearing a brood in it. Is not such persistency of purpose worthy of admiration, notwithstanding it is exhibited by a harmful bird?—L. J. STROOP, *Waxahachie, Ellis county, Texas, August* 24, 1870.

AMERICAN PANTHER.—The Catamount, Cougar, or Indian Devil, as the American Panther (*Felis concolor*) is called, is said to be still common in the wild regions of the Adirondacks. Mr. H. H. Bromley of the Chasm House informs me that dead ones have often been found in the woods, having been killed by the spines of hedge-hogs which they had attacked.—F. W. P.

NOTES ON SOME OF THE COAST FISHES OF FLORIDA. — During a residence of three months in East Florida last winter, I sailed up and down the Halifax, Indian, and Hillsboro' rivers, and enjoyed fine sport with the fishes of that region, many of which I found to be of the first excellence on the table.

Sheepshead (*Sargus ovis* Mitchell). At New Smyrna, near the Musquito Inlet, we caught them in great numbers of two to seven pounds weight. In two hours, at half flood, two of us would often get from twenty to thirty fish, averaging four pounds each; bait, clams or conchs.

Bass, or Red-fish (*Corvina ocellata* Cuv.). This fine fish I found plenty all along the coast about the inlets. They are from two pounds to fifty, as I am informed by fishermen; but the largest taken by me weighed twenty-five pounds, and was caught in the narrows of the Indian River, by trolling with a mullet bait and hand line. At about half flood we caught them by casting a hand line, with mullet bait, far off into the surf, or by fishing with a rod and line where the channel ran near the beach. This fish much resembles the striped bass (*Labrax lineatus*), in habits, and is quite as game a fish on the hook. I had many hooks and many yards of strong bass line taken away by them, as they fight fiercely to the last. This is a very good fish on the table; rich, firm and delicate. Its color is very brilliant when recently taken; steel blue on the back, of a golden copper hue on the sides, and white beneath; scales large; tail square; first and second dorsal with sharp spines; teeth numerous and small in the jaws; large and enamelled on the vomer.

Cavalli or Crevallé (*Lichia Carolina* DeKay). Family of Scombridæ. Shape between that of dolphin and mackerel, though deeper than either; color blue, gold and silver, and changeable like the dolphin; from two pounds to fifteen; goes in schools and takes a bait of mullet eagerly; will also take a red rag or spoon, trailed behind a boat; a very active and strong fish; good eating, though rather dry. Holbrook in his "Fishes of South Carolina," seems to confound this species with the Pampano (*Bothrolæmus Pampanus*), a very highly prized table fish of the southern waters. The latter, I am informed by old fishermen on the Florida coast, never takes a hook, and can only be taken in nets, and at night. It much resembles the Crevallé in appearance.

Sea-trout (*Otolithus Carolinensis* Cuv.). This belongs to the same family as the Weak fish of the New York coast. In shape and color it resembles the lake trout of the Adirondack region, but wants the adipose fin which distinguishes the salmon, and of course is not a true trout. It is an active game fish, takes a mullet bait or clam; weight from two pounds to fifteen; color steel blue on the back and sides, with black spots; under parts, white and silvery; inside of mouth, yellow; head small, teeth strong, tail waved in form, with a double dorsal fin, with spines.

Black Snapper (*Mesoprion pargus* Cuv.). Belongs to the family of Percidæ; is in form like the tautog; a bottom fish, with large mouth and strong teeth; bites eagerly at clam or mullet, and pulls hard; silvery in

color when first taken, then turns red, and lastly black; is one of the best of the southern table fishes; weight, from four to sixteen pounds.

Crab-eater, Sergeant fish (*Elacate Atlantica* Cuv.). Family of Scombridæ, or mackerels; found along the shores of the inlets, where it lurks for prey among the mangrove roots; very voracious; takes clams or mullet bait; color, silvery, with a black stripe along the sides; hence its local name of Sergeant fish; the under jaw longer than the upper; weight up to twenty pounds; a good table fish, though inferior to the former.

Whiting or King-fish (*Umbrina alburnus* DeKay). Shaped like a perch, double dorsal with strong spines; color, gray and black above, yellowish white beneath; mouth and teeth small; bottom fish of deep water; takes clam bait; very good table fish; weight, from one to two pounds.

Croker (*Micropogon undulatus* Cuv.). A southern fish of the perch family; in form, deep like the sheepshead; color, silvery; takes clam bait eagerly; weight, from one to two pounds; a good table fish.

Hog-fish, Sailor's Choice (*Hæmulon fulvomaculatum* Mitchell). Shaped like the last; a good pan fish; weight, from half a pound to a pound; takes clam bait on the bottom.

Cat-fish, of the salt-water (*Galeichthys marinus* DeKay). Handsomer in form and color than the fresh-water cat; has a forked tail and very high dorsal fin; takes fish or clam bait on the bottom; weight, 10 to 15 pounds.

Black trout (*Grystes salmoides* Lacepède). This is a fresh-water fish of the perch family, much resembling in appearance and habits the black bass of the western waters, except that it has a larger head and mouth, and grows to a larger size, say to twelve or fifteen pounds. It takes live bait, spoon or bob, which is a bunch of colored feathers with three hooks concealed among them.

Besides the above fishes, these waters contain blue fish, Spanish mackerel, beluga, mullet, Jew fish, drum, shad, lady fish, porpoise, sharks, saw fish, sting ray, the hawk's bill turtle, the soft-shelled turtle, the green turtle, clams, oysters and crabs, of various kinds. — S. C. Clarke.

GEOLOGY.

Discovery of Lower Carboniferous fossils on the Rio Tapajos. — I am just returning from a very interesting and profitable trip up the Rio Tapajos, where I have had the good luck to discover an extensive set of limestones, sandstones, and shales, of lower carboniferous age, from which I have made a very large collection of beautiful fossils. As near as I can ascertain at present, I have at least one hundred and fifty species of Brachiopods, Lamellibranchs, Polyzoons, Gasteropods, Trilobites, fishes, and a few plants, the majority of the species being determinable. Of the Brachiopods I have some magnificently preserved specimens, showing interiors. I am going back to Pará to give up my little steamer and divide up my party. I then return to the Tapajos with a very small party, including a photographer, to examine more carefully,

not only these rocks, but to study the Amazon sandstones and clays. I have seen nothing to cause me to change my opinion about the age of the last named formation. I have not succeeded in finding any fossils in them. I have found beautiful fossil leaves of apparently recent plants, in a recent ironstone. In the hill of Creré, Monte Alegre, and near Santarem, beds of basalt occur. — C. F. Hartt, *on board Government Steamer "Jurupensem," near Monte Alegre, Rio Amazonas, Oct. 5th*, 1870.

New Fossil Fishes. — Prof. Cope has recently studied the genus *Saurocephalus* and allies, from the Cretaceous, and states as a result, that these fishes are not in the least related to the *Sphyrænidæ*, where they have been placed heretofore. The structure of the mouth is like that of the *Characinidæ*, while the neural arches are distinct and the tail vertebrated as in *Amia*. The pectoral spines have been described by Leidy, as those of a Siluroid, under the name of *Xiphactinus*; and the beautifully segmented rays referred to Ptychodus, by Agassiz, he regards as the anal or caudal rays of *Saurocephalus*. The affinities might be more correctly expressed as combining characters of Salmo and Amia. Professor Cope describes a new genus, *Ichthyodectes*, type species *I. ctenodon*; the former differs from the known genera, *Saurocephalus* and *Saurodon*, in not having the series of nutritious foramina on the inner side of the alveolar ridges. He refers these fishes to a new family, under the name of *Saurodontidæ*.

Plasticity of Rocks. — The old cobble-stone pavement in Waverly Place, between Broadway and Mercer street, being now in process of removal, my attention has been drawn to the forms of the stones, especially the harder ones, quartzites, etc. The coarser granulated paving stones have generally crumbled, but the compact stones have been modified — convex surfaces in one case fitting into concave in another; none of them retaining a normal form. Now, although the crown of these stones has been worn by the attrition of constant and heavy travel, no such wear can have taken place on their perpendicular surfaces, and I am therefore convinced that they have been moulded into one another by pressure only. On conversing with the workmen, they all concurred as to the fact, and the foreman stated that his attention had been called to it before. Very probably I am myself only repeating what is already well known to others. — George Gibbs, *New York*.

Salt Plains in New Mexico. — Brevet Major General August V. Kautz, U. S. Army, writing from Fort Stanton, New Mexico, informs me that there is a valley of some two hundred miles long and twenty wide, lying between the Sierra Blanca and the San Andreas and Occura mountains, in that Territory, in which there is no stream, and only a few alkaline springs and salt lakes, or ponds. Where the road from Fort Stanton to El Paso crosses it, about sixty miles south of that post, is a plain of white sand, apparently granulated gypsum, which has drifted into mounds, forty and fifty feet in height. Water of a strongly alkaline character is obtained by digging a few feet, and around the edges of this district, salt marshes exist, where in the dry seasons, great quantities of almost pure salt may be collected. The sand is so white and the plain so extensive as

to give the effect of snow scenery. As I do not remember to have seen a description of the place in print, I send you this note with a specimen of the sand forwarded by General Kautz. — GEORGE GIBBS, *New York*.

MICROSCOPY.

A NEW FORM OF BINOCULAR FOR USE WITH HIGH POWERS OF THE MICROSCOPE.* — Of the several forms of binocular arrangement for the microscope which have hitherto been constructed, only such as are adapted for use with low powers exclusively, have as yet come into general use. Of these, the Wenham prism is the popular favorite, and hardly any other form is employed at all by British or American constructors. Mr. Wenham's binocular, when employed with powers below about one-half inch, leaves nothing to be desired; but with higher powers than this, the field is so imperfectly and so unequally illuminated that it ceases to be available.

The Wenham binocular, like the original binocular of Dr. Riddell, and like the different forms constructed by Mr. Nachet, divides the light, after it has passed the objective, by a vertical section passing through the middle of the entire bundle of pencils, into two equal portions, one of which is directed to each eye. But although the entire body of the light is thus equally divided, the same is not true of the several pencils which make it up. Only those pencils in fact can undergo equal division whose radiant points in the object lie exactly in the plane of the section. All others will be divided unequally, and the inequality will be greater in proportion as the radiants are more distant from that plane. If the division could be effected at the centre of the front lens of the objective, the inequality just spoken of would disappear; but such a division is of course impracticable. With objectives of low power, the base of each conical pencil of rays (which is the area of the front lens of the system) is so large, that the inequality of illumination consequent upon the unequal division of the pencils themselves is not sufficiently great to be objectionable; but with high power objectives, the pencils are very slender; and at the distance behind the combination at which it is necessary to place the binocular construction, many are very disproportionately divided, and many escape division altogether.

By the introduction of an erector into the body of the microscope, the pencils, which cross each other once in entering the front lens of the combination, may be made to cross a second time; and it is obvious that if the dividing apparatus of the binocular be introduced at the point of this second crossing, all the pencils will be divided with the same equality as they would be if the division could be effected at the centre of the front lens itself. Availing himself of this principle, Mr. Tolles, some years since, constructed a binocular eye-piece which solves completely the optical problem under consideration for all powers; but this instru-

* Read by F. A. P. Barnard LL. D., President of Columbia College, N. Y., before the Microscopical Section of the American Association for the Advancement of Science, Troy meeting.

ment is costly, and apart from this objection, it has for some reason or other failed to become a favorite with those who have used it.

It is now two or three years since Mr. Wenham suggested the practicability of constructing a binocular for high powers, by means of a contrivance which should reflect one-half the light of each pencil and transmit the other half. This plan was to take a glass prism with parallel surfaces, and to cut this by an oblique section at an angle suitable to reflect one-half the light which should be incident upon it after entering the prism perpendicularly to one of the original faces. The two portions of the divided prism being replaced in position to reconstruct the original prism, the surfaces of section being very nearly but not quite in contact, the whole is placed behind the objective, when the transmitted portion of the light will give one image, while the reflected portion, after a second reflection within the prism, will furnish the other. In this arrangement there is a possibility of some confusion in the image seen by reflection, in consequence of the duplication of the reflecting surface. On this account, or for some other reason not stated, Mr. Wenham did not follow up his invention.

In the January number of "Silliman's Journal" for 1868, Professor Hamilton L. Smith, now of Hobart College, described a binocular arrangement invented by himself, in which it was proposed to effect the division of the light by means of a long thin glass reflector placed very obliquely in the body of the microscope. As both surfaces of such a mirror will reflect light with intensity, it is necessary that these surfaces should not be parallel. It was Professor Smith's first idea to make the reflecting plate sufficiently wedge-shaped to throw the second image out of the field; but experiment showed him that, by making the inclination of the surfaces very slight, the images might be made perfectly to coalesce. This construction involved the disadvantage that the length of the body of the microscope could not be varied, but it was attended with an important saving of light. Hitherto Professor Smith's binocular has not been constructed by regular opticians, and its merits are not fully known. The constructions by Professor Smith himself perform very well, but have a rather limited field.

Messrs. Powell and Lealand, of London, have patented a binocular which resembles Professor Smith's in that it divides the light by reflection at the first surface of a glass mirror; but the surfaces of this mirror are parallel, and the image from the second surface is got rid of by giving to the glass considerable thickness. The reflected rays are reflected a second time by means of a right angled prism. As this arrangement is actually constructed, the image seen by reflection is greatly inferior in brilliancy to that formed by the transmitted rays. In fact, when very high powers are employed, the image by reflection is practically unavailable for any useful purpose. This evil might be remedied by increasing the angle of incidence at which the rays from the objective fall upon the first reflecting surface; but this expedient would be attended

by a large increase in the amount of light lost at the second reflecting surface, and by a corresponding diminution of the brightness of the image seen by transmission.

Binoculars constructed on the principles of those last described may be called *cata-dioptric*, in contradistinction from those which split the body of the light geometrically, and which are properly denominated *stereotomic*. They have not the advantage which belongs to stereotomic binoculars, of presenting the object viewed in all its three dimensions. But they permit what most observers regard as very desirable, or find at least very comfortable, the use of both eyes at the same time. It is true that there are many whom practice has so accustomed to the use of a single eye, that they profess to suffer no inconvenience from this mode of observation, and regard binoculars with indifference except so far as they are recommended by their stereoscopic effect. But however slight may be the momentary inconvenience attendant on observation with a single eye, it is believed that no microscopist can continue to observe in this manner for a series of years, without finding that his eyes have lost the equal power which they once possessed of accommodating themselves to distances. It seems impossible to prevent this result from supervening sooner or later, unless by maintaining a strict impartiality in the employment of the eyes alternately at the microscope; and this is what few remember, or if they remember, are disposed to do. If by the use of a binocular this evil can be prevented, this fact alone is sufficient to make a good form of this instrument adapted to the higher powers desirable. Such a form is believed to have been found in the construction now to be described.

If a rectangular prism of calc spar be cut with four of its faces parallel and the other two perpendicular to the direction of the optic axis, a ray of light incident perpendicularly upon any one of the lateral faces will be divided by double refraction into two rays, but both of these two rays will pursue the common direction of the incident ray continued. There is a large difference between the two indexes of refraction. The index of the ordinary ray is 1.6543, and that of the extraordinary, 1.4833. If now the prism be divided by a plane section oblique to the axis, the two rays co-incident in direction, as above supposed, will be unequally reflected by this plane. And the ordinary ray will suffer total reflection at an angle at which the extraordinary ray is almost totally transmitted. The angle of total reflection for this ordinary ray is 37° 11′, while that at which total transmission occurs for the extraordinary ray is 34° 2′. From 34° to 37°, the amount of light reflected from the extraordinary ray is inconsiderable; amounting at the latter angle not quite to eight one-thousandths of the entire ray, and to four one-thousandths of the total intensity of the ray originally incident upon the prism. If, therefore, the supposed calc spar prism were cut by a plane, making an angle of 37° 11′ with one of its lateral faces, a ray incident perpendicularly upon this lateral face and meeting the plane of section, would be half reflected and half transmitted,

or so nearly so that the inequality would be imperceptible. Moreover, the very minute portion of the extraordinary ray which would undergo reflection, would deviate more than two degrees from the direction of the reflected ordinary ray; and so, supposing this prism to form part of a binocular arrangement for the microscope, would be thrown out of the field.

But the pencils of rays which go to form the image in the body of the microscope have a certain angular spread. If, therefore, the axis of the central pencil be perpendicular to a given plane, those of the lateral pencils will be inclined to the same plane. Accordingly if this central axis were to be incident on the supposed plane of section at 37°, the incidences of the lateral pencils would vary between 34° and 40°, or possibly between limits somewhat larger. Also as the lateral rays of each pencil are inclined more or less to the axes of the same pencils, the limits of maximum and minimum incidence would be more largely extended by this circumstance. For low powers we should have to allow for a range of incidences embracing perhaps eight or nine degrees of difference. For very high powers this range would hardly exceed six.

If the incidence of the central axis is fixed at 37° 11′, the angle of total reflection for the ordinary ray, then the lateral pencils of this ray, whose incidences are less than 37° 11′, will be to a certain, but not very considerable, degree, transmitted. This does not affect the definition of the image seen by transmission, but it gives it a slight superiority to the other in respect to brightness. If, however, the incidence of the central axis is made as great as 39°, the two images become sensibly equal in brightness. In this case some of the lateral pencils of the extraordinary ray will attain an incidence of 42°, at which point the amount of reflection is quite sensible, but this does not materially affect the middle of the field, nor is it sufficient to impair, perceptibly, the brilliancy of the image seen by transmitted light.

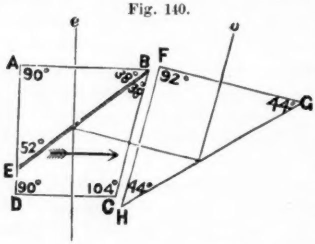
It is now about three years since the plan of a binocular founded on the principles above explained, was devised by the writer of this paper; but this plan was not immediately realized in consequence of a difficulty encountered in obtaining calcite prisms suitably prepared. Opticians were applied to in London, and in this country, but no one was found willing to attempt the preparation. In the spring of 1869, Professor Rood, of Columbia College, kindly lent his aid to the accomplishment of this undertaking, so far as to verify experimentally the anticipations of theory; but time would not permit him to give to the prisms the finish required for a perfect instrument. The work was finally done during the following summer by Hoffman of Paris, with results entirely satisfactory.

In the original construction the calcite prism was made rectangular. The ordinary ray, after reflection from the surface of section, emerged from the terminal plane at an incidence of twelve degrees. It was reflected a second time by means of a triangular prism of flint glass having nearly the same index of refraction, of which the first surface was placed

parallel to the terminal plane of the calcite. It was thought that the very nearly equal and opposite refractions thus suffered by the ray would suffice to prevent sensible aberration; and this is nearly true. But the unequal dispersive power of the two substances makes itself slightly manifest when the objectives used are low; though this defect disappears in the case for which the instrument is intended — that is with high powers. Nevertheless, it has been thought best in new constructions now preparing, to give such an obliquity to the terminal plane of the calcite that the reflected ray may be incident upon it perpendicularly, and to modify correspondingly the flint glass prism. On the whole it appears to be best also to give the plane of section an inclination of about 38° instead of 39°. Indeed it would appear that, for low powers, the lower angle is preferable, and for high powers the higher; doubtless because, on account of the larger range of differences of incidence in the former case, there is a larger reflection of the extraordinary ray, which is greatly reduced by a very small change in the angle of incidence. For this reason it is convenient to have the system of prisms so mounted that it can receive a slight rotation about an axis perpendicular to the plane of reflection, and to adjust it to the position most satisfactory with the power employed.

The annexed figure (140) will serve to give an idea of the form of construction now employed. ABCD is a section, parallel to one of the lateral faces, of a calcite prism, originally rectangular, of which the optic axis is parallel to the section, and to the sides AB and DC. This prism is divided by a plane perpendicular to ABCD, making an angle of 38° with AB and 52° with AD. Also, the face, BC, inclined 14° to the original face of the rectangular prism, is made to replace that face. The prism, when completed, should have its lower face square, and the side of the square which is equal to DC, should be six-tenths of an inch. The remaining dimensions will be determined by this, and by ED, which should be three-twentieths of an inch. The surfaces of section, BE, may be brought very near to each other. In the construction actually employed they have been separated only by a single thickness of tinfoil, introduced at each of the angles.

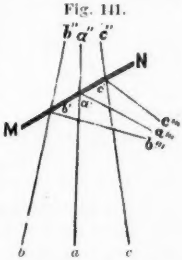
Fig. 140.



The prism, FGH, is of flint glass with a refracting index as high as 1.56 or higher. It is isosceles, having an obtuse angle of 92° at F, the acute angles being equal and each 44°. The side, FH, being parallel to BC, a ray incident perpendicularly upon DC, and doubly refracted by the prism, is resolved into the two rays, *e* and *o*, of which the first is transmitted, and the second, reflected by BE, passes perpendicularly through the two surfaces, BC and FH, is a second time reflected by GH, and finally emerges

at right angles from the face FG. The inclination of *o* to *e* is twelve degrees. It would be preferable to make it somewhat less, as this inclination allows only a length of body to the microscope of about seven inches. By employing in the prism, FGH, glass of higher refracting power, it may be made less, and by using calcite for this prism, or in other words, by making BCDE and FGH all of a single piece, the same object may be attained to any desired degree. The objections to this latter plan are two-fold. The first relates to the difficulty of construction. It is said that the Wenham trapezoidal prism of glass is troublesome to make. The difficulty would be much increased in the use of such a material as calcite, especially when it is necessary to preserve an exactly prescribed relation between the faces of the prism and the optic axis. The second objection is found in the consideration that, in order to adapt the tubes of the binocular to the eyes of different observers, it is necessary to give to one of the tubes an angular movement, moving the prism, FGH, at the same time, by half the same angular amount, as is done by Mr. Nachet in one of his forms of binocular; or to move this tube and prism laterally, as Mr. Nachet has also done in another of his forms. This necessity arises from the fact that, if the tubes are sufficiently inclined to each other to permit an accommodation to different eyes by running them in and out, as is done by Mr. Wenham, they must be made shorter than is desirable. The reflected pencils might be made to cross the transmitted before reaching the eye, as is done both in Wenham's and in Powell and Lealand's contrivances; and this would remedy the inconvenience last mentioned; but it would necessitate the use of a prism, in place of FGH, of difficult construction, and of greater size than is desirable.

Fig. 141.



But there is another objection to the crossing of the pencils which is more serious. This binocular, as actually constructed, produces, when used with moderate powers, a sensibly stereoscopic effect. Nor is it difficult to understand why it should do so. In any stereotomic binocular, Wenham's for instance, it will be observed that the half of each pencil which falls upon the front lens of the objective, is carried to the opposite eye; and this ought to be so, because the image actually seen is reversed in position. Now, by considering the figure annexed (141), it will be seen that if $aa'a''$ be the axial ray of a converging pencil of which $bb'b''$ and $cc'c''$ are the lateral limiting rays, and if a transparent reflector, MN, be interposed obliquely in the path of this pencil, the angles of incidence of all the rays intermediate between a' and b' will be larger than those of the rays between a' and c'. Of the reflected rays, therefore, those between a''' and b''' will be more abundant than those between a''' and c'''; while of those which are transmitted the excess will lie between a'' and c'', and there will be a corresponding deficiency between a'' and b''. Now if all

the light except these excesses should be extinguished, it will appear at once that the illumination still outstanding would be such as is required to produce stereoscopic vision; that is, each half of the pencil would go to the opposite eye. In our calcite prism, we have seen that in, for instance, the central pencil, there is total reflection for the ordinary ray between a' and b', but that there is some transmission toward c'. The extraordinary ray, on the other hand, is almost totally transmitted between a' and c', and loses something by reflection toward b'. These effects are more marked in some of the oblique pencils, and the consequence is, that, with low powers, the stereoscopic appearance is very perceptible. To cross the reflected rays upon the transmitted behind the prisms would therefore be productive of a pseudoscopic effect which would be objectionable. But with high powers, on account of the small difference of incidence existing in that case between bb' and cc', the image appears plain.

As a test of the performance of this binocular, it may be mentioned that, by means of it, the most difficult natural objects have been resolved by observation with both eyes, or with either eye singly. With a Wales' objective marked one-thirtieth, but more exactly rated one-twenty-fifth, and with the B oculars, the Providence Grammatophora is thus resolved with great facility.

When the power used is below one-fourth, there is a little haziness produced in the image seen by reflection, in consequence of the mingling of the, to some extent, reflected extraordinary ray, from the clear field surrounding the object. This effect is immediately removed, by placing over the slide a card, out of which has been cut a slip having the width of the field. Such a card, or a similar thin plate of metal, may be easily secured to the stand, so that the stage and slide may move beneath it while it remains fixed. This haze is moreover suppressed still more easily by slightly tilting the system of prisms, so as to diminish by a degree or two the angle of incidence upon the reflecting plane of section. This really gives to the image seen by transmission the advantage in respect to illumination; but as, with low powers, both images are strongly illuminated, the difference is scarcely noticeable. It is well, therefore, in mounting the prisms, to provide some system of adjustment by which the position may be varied to correspond to the power employed.

Some experiments have been made with calcite prisms cut in such a manner that the extraordinary ray proceeding from common light perpendicularly incident upon the first surface, should fall at a smaller incidence than the ordinary upon the surface of the reflecting section. Thus, if, in figure 140, the optic axis has the direction BE the extraordinary ray will deviate toward the left, from the ordinary, after perpendicular incidence on DC, by nearly five degrees. This is favorable to the transmission of the extraordinary ray through BE; but as the index of extraordinary refraction is considerably greater in this direction, the amount of loss by reflection is about the same as before. The construction employed at first gives results which are very satisfactory; but it is designed to pur-

sue experiment further, and with the able assistance of Mr. Joseph Zentmayer, whose zeal for the improvement of the microscope has induced him to undertake the rather troublesome task of preparing the prisms, it will soon be ascertained whether or not any material advantage can be gained, by adopting a different plan of cutting them.

NOTES.

Our readers are doubtless aware that Congress at the last session made an appropriation of $50,000 for Arctic exploration, with the promise that the scientific operations of the expedition were to be prescribed by the National Academy of Sciences. Captain Hall was appointed by the President of the United States to command the expedition in question, and a commission of the National Academy, recommended by Professor Henry are to act in concert with him, and prepare a manual of scientific inquiry for the use of the expedition, which will, undoubtedly, interest a large circle of readers when published.

Mr. A. Hyatt has been appointed Professor of Palæontology at the Massachusetts Institute of Technology. Mr. E. S. Morse has been chosen Professor of Comparative Anatomy and Zoology at Bowdoin College, and has been appointed Lecturer in the same branch at the Maine Agricultural College. Dr. A. S. Packard, jr., is to lecture on Economic Entomology at the same institution. Mr. B. K. Emerson has recently been elected Professor of Geology at Amherst College, the chair filled for so many years by Dr. Edward Hitchcock, Senior.

Chicago offers a new publication for general patronage, under the title of the "American Journal of Microscopy." The first number, for November, is of quarto size and contains sixteen pages. The Journal is to be published monthly, by George Mead & Co., 182 South Clark Street, Chicago. Mr. Mead is the editor. Subscriptions at $1.00 a year are solicited, and contributions on microscopical and kindred subjects are requested from all parts of the world.

Dr. Hagen has recently returned from Europe, having purchased, through funds furnished by a lady in Boston, for the Cambridge Museum, a Parisian collection of weevils of great extent and value. We are glad to know that he has brought over his own unrivalled collection of Neuroptera. Its presence in this country is most fortunate for this department of entomology.

The addition to the building for the Museum of Comparative Zoology at Cambridge, at an expense of upwards of $60,000, is rapidly going up. Professor Agassiz has returned to Cambridge with restored health, and with new plans for the enlargement of his Museum.

The Lyceum of Natural History of New York has lately started forwards with renewed vigor, and now issues its "Proceedings," as well as "Annals." Three signatures of the "Proceedings" (from pages 1 to 44), have been received, and contain abstracts of several interesting papers read at the meetings in April and May last.

Gradually the unpublished results of the labors of Dr. T. W. Harris are being given to the public. Mr. P. R. Uhler, of Baltimore, has ready for publication by the Boston Society of Natural History, descriptions of the Hemiptera of the Harris Entomological collection.

Congress is about to print an entomological report by Townend Glover, the entomologist of the Agricultural Department. It will form an exceedingly useful work, and will deserve the widest circulation.

The well-known Paris dealer in insects, M. Deyrolle, took flight to London with his immense stock of insects, before Paris was actually invested.

Mr. J. A. McNiel, who has made two expeditions to Central America, is now in Philadelphia preparing for a third Archæological Excursion to Nicaragua.

Prof. O. C. Marsh of Yale College, has just returned, with his party, from the Rocky Mountains. The Expedition started in June last.

All our French exchanges, months ago, were suspended.

ANSWERS TO CORRESPONDENTS.

A. D. H., Tuscaloosa, Ala.—The larva taken from oak wood is the Oak-tree Borer (*Xyleutes robiniæ*), one of the silk worm family (*Bombycidæ*). It often does damage to the red oak, though the moth, a large ash gray species, is comparatively rare.

C. E., Cincinnati.—A light dredge, such as is described on p. 269 and figured on p. 274, Vol. iii. of the Naturalist, will answer your purpose. A stout clothes line will do for a rope; with a five-pound window weight or fishing lead to sink the dredge. In sounding, use a stout fishing line, with a hollowed two-pound lead weight tied to the end, the hollow to be filled with soap. Fathoms can be measured off with strips of red tape tied in the cord. Look out for minute worms and small crustacea, such as the water fleas, and especially the larger shelled forms, such as Lymnadia, Estherea, etc.

E. S. M., Mitchell, Ind. Your photograph is that of *Dynastes Tityus*, male. A pair would be very desirable for the Museum of the Academy.

H. G., Detroit.—We requested an answer to your question from a physiologist of the highest standing, and have received the following in reply: "The subject is a very important one, as experts are often called upon to decide whether a given blood-stain is or is not human. Many enthusiastic microscopists have full confidence that nothing is easier than to decide the matter by looking through their instruments, until they find themselves cross-questioned by a sharp lawyer.

Human blood is easily distinguished from that of many mammals, birds, reptiles and fishes, by the size and form of the globules; and tests, both chemical and microscopical, have been proposed for distinguishing human blood from that of some of the domesticated animals. In medico-legal cases, such, if good, would be of the utmost importance, but it is generally conceded that none exist which can be admitted as absolute. If an observer had given him blood from man and the dog, without knowing any circumstance which would lead to an opinion as to their origin, there is no valid sign which would justify him in going into court and saying which was and which was not human. The test of odor given off when sulphuric acid is added to the blood, however successful it may have once been in the hands of some experts, has not, after many years, come into use, and that of the size and appearance of the globules also fails, as the globules of some of the domesticated animals offer the same characteristics as those of man."